Project # CS-1114A-99
Univ. of Florida

Jennifer Jacobs → watershed hydrology

Suresh Rao (Purdue Univ.) → vadose zone hydrology

Debbie Miller → vegetation ecology

George Tanner → vegetation ecology

Bill DeBusk (PI) → soil biogeochemistry

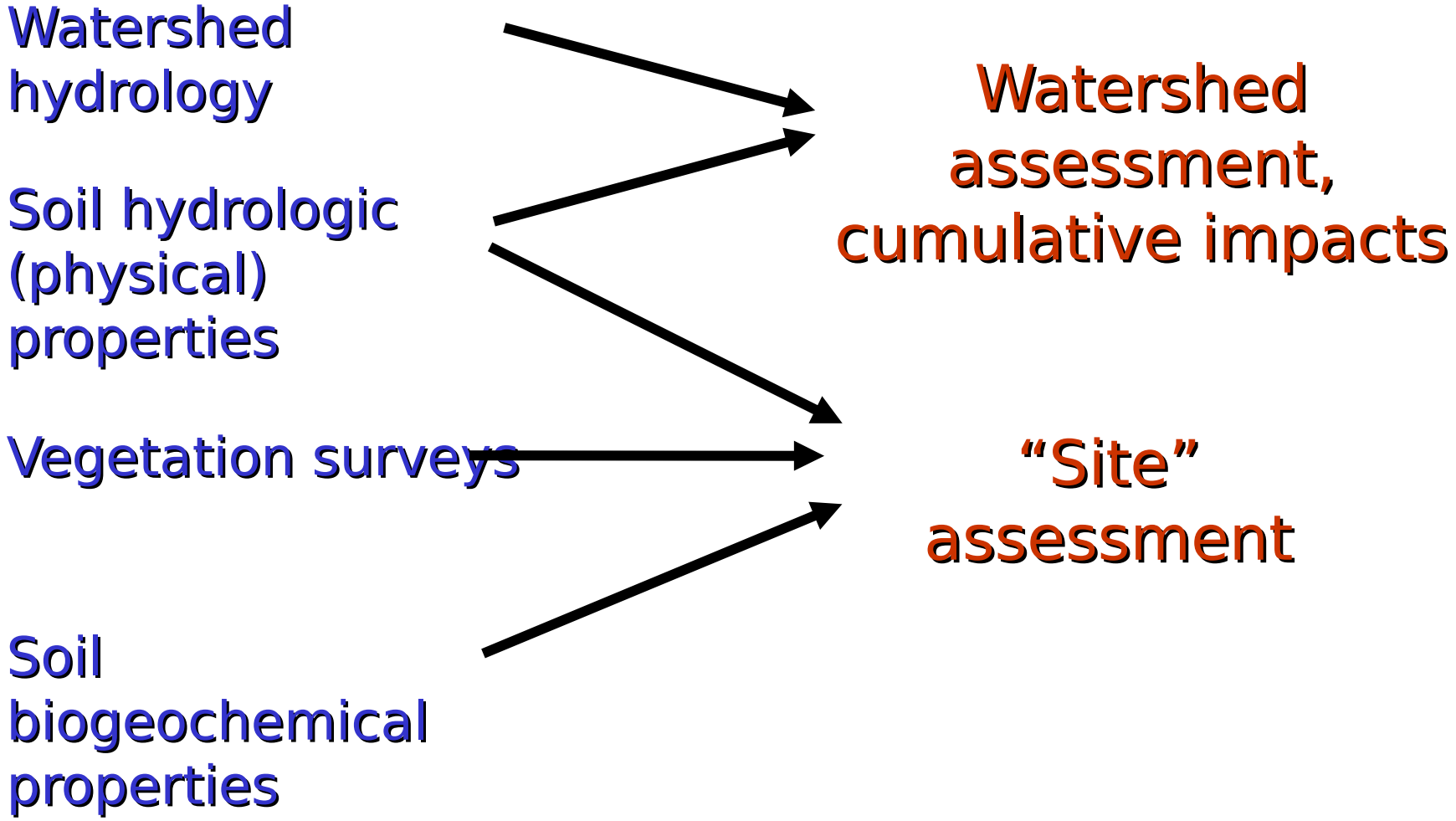
Ramesh Reddy → soil biogeochemistry

Joe Prenger → soil microbial ecology, enzymes

Andy Ogram → soil microbial ecology, functional diversity

Wendy Graham → spatio-temporal analysis

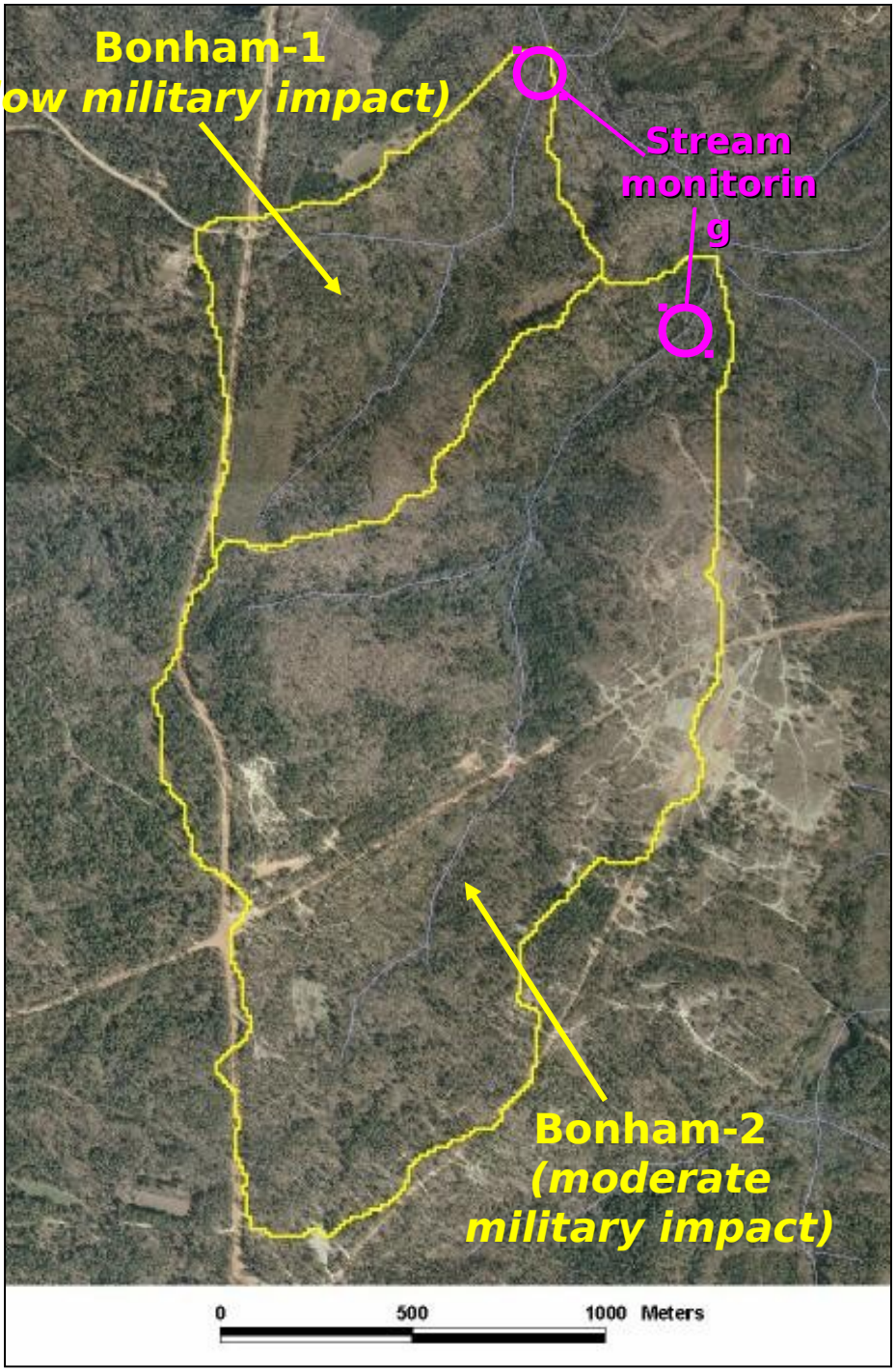
RESEARCH APPROACH

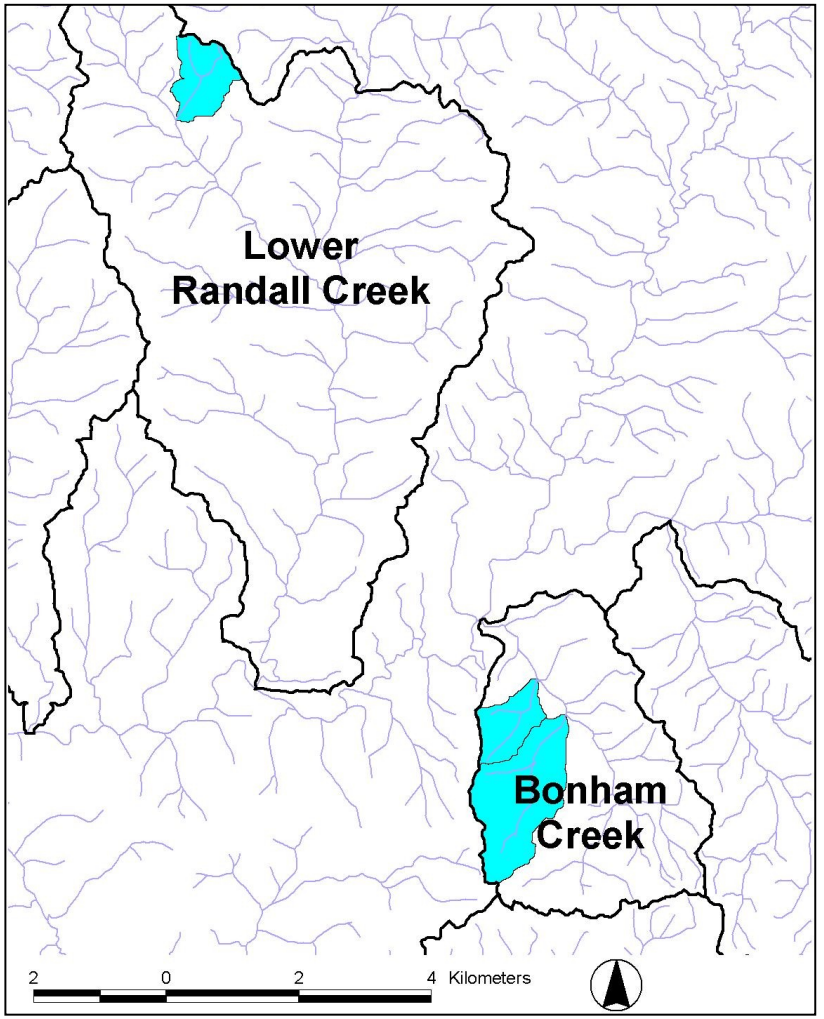


WATERSHED HYDROLOGY

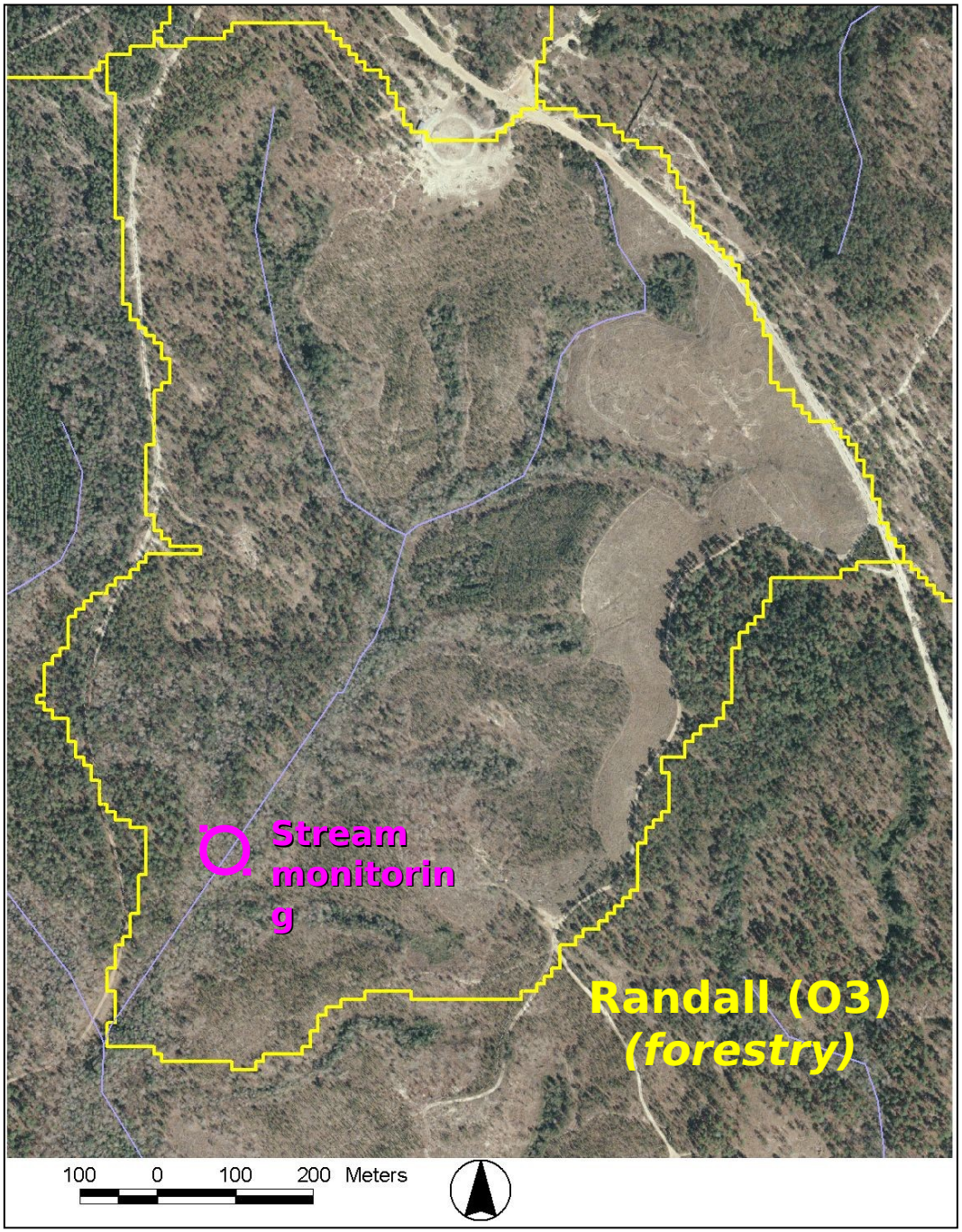
- Stream monitoring
  - Stage / discharge
  - Water quality (Hydrolab)
- Canopy throughfall / interception
- Flow routing, water budget
- Watershed modeling
  - e.g. TOPMODEL

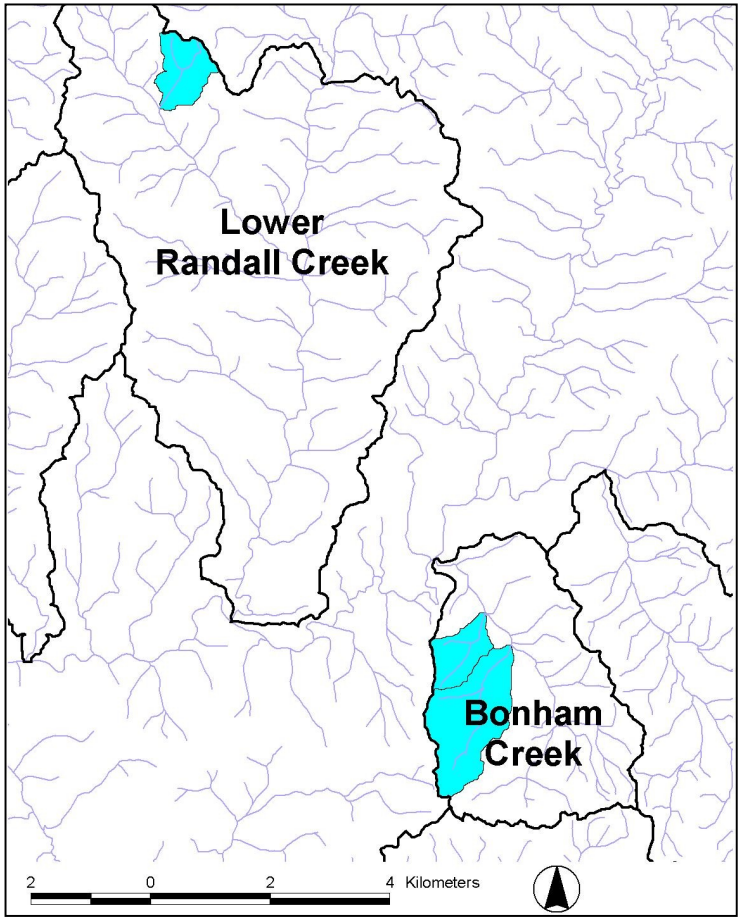
WATERSHED HYDROLOGY





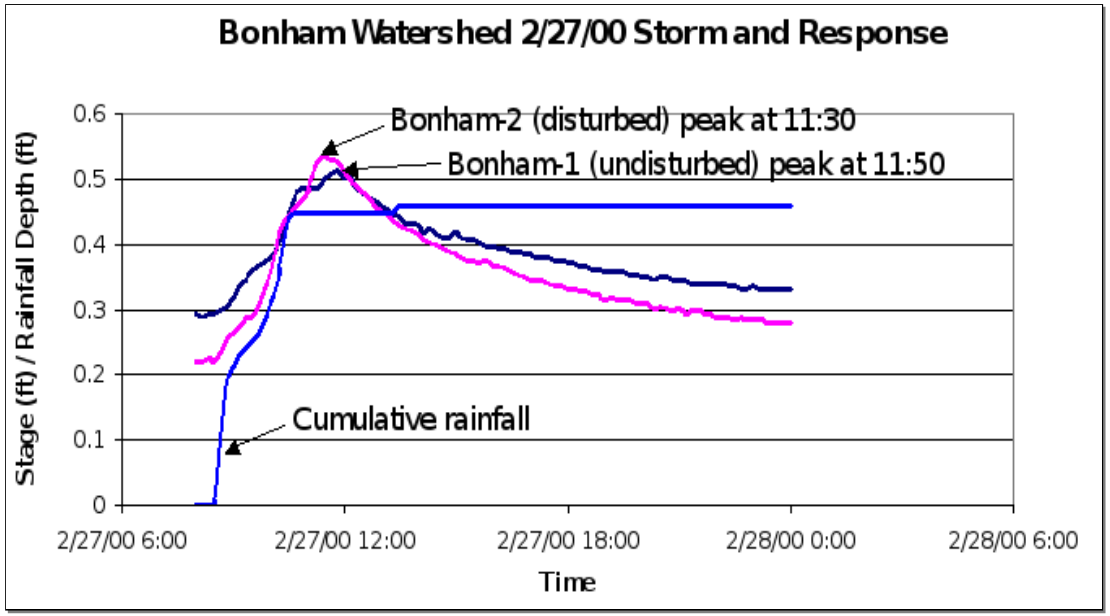
WATERSHED HYDROLOGY

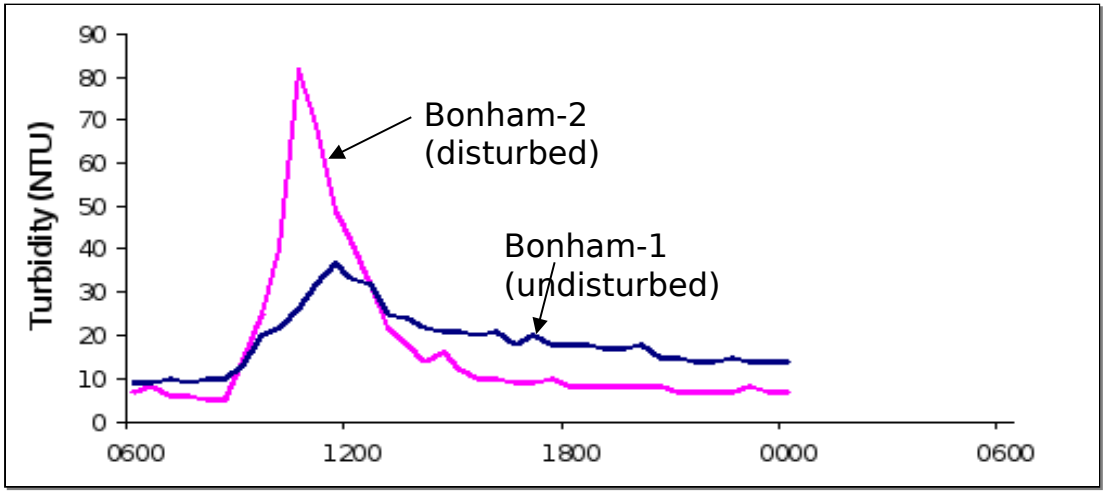




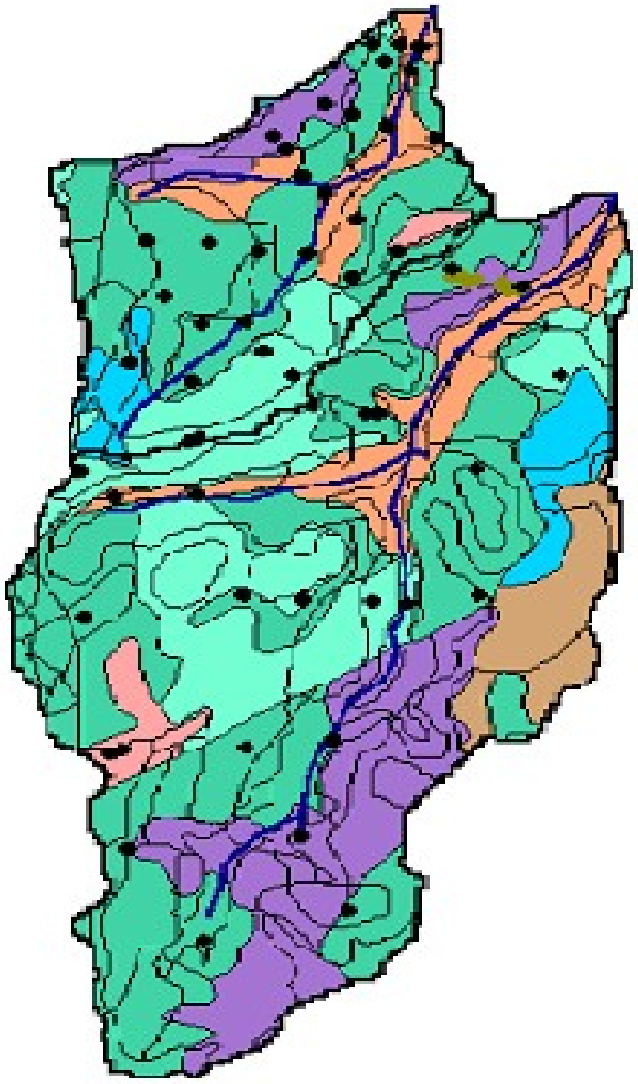
WATERSHED HYDROLOGY

Stream monitoring





WATERSHED HYDROLOGY



Canopy throughfall collection

Measures precipitation available for infiltration and runoff

WATERSHED HYDROLOGY

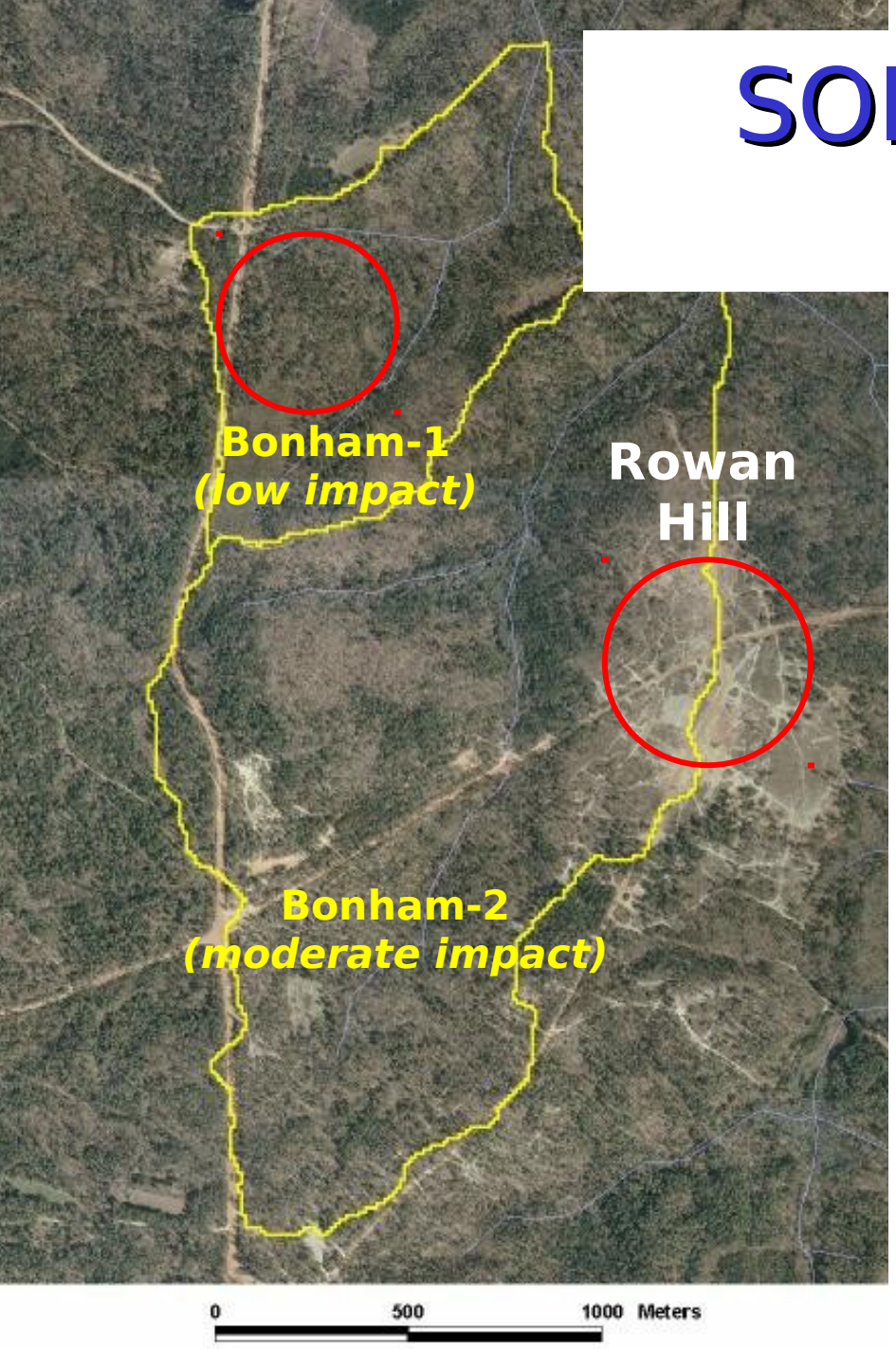
Canopy interception

- Important parameter for watershed models
- Preliminary analysis shows a relationship between throughfall and gross storm precipitation based on land cover
- These relationships will be formalized to develop a spatially-distributed predictive model of canopy interception
- Preliminary results for pine forests indicate that the Gash-Rutter model provides reasonable results

SOIL HYDROLOGIC PROPERTIES

- Soil texture, bulk density
  - Relate to erosion, deposition, compaction
- Permeability (infiltration rate)
- Runoff characteristics – surface / subsurface flow
- Soil-water content / storage

SOIL HYDROLOGIC PROPERTIES



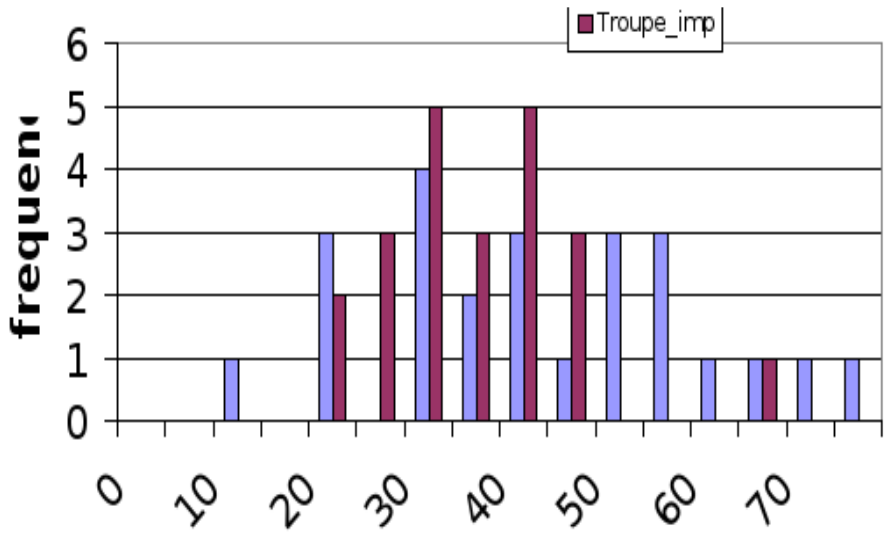
- Moisture release curves
- Sat'd hydraulic

***Goal:* Evaluate changes in soil water flow and storage resulting from soil and vegetation disturbance.**

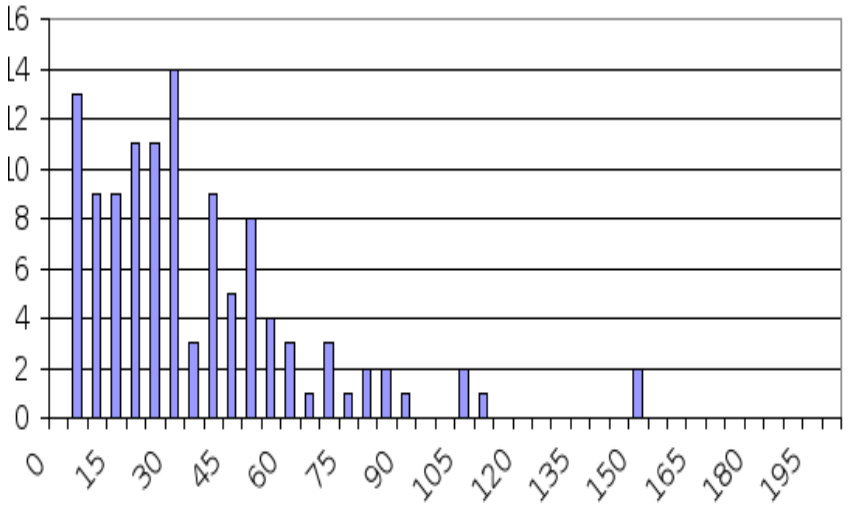
SOIL HYDROLOGIC PROPERTIES

Field permeability measurements

Sites within Troup series



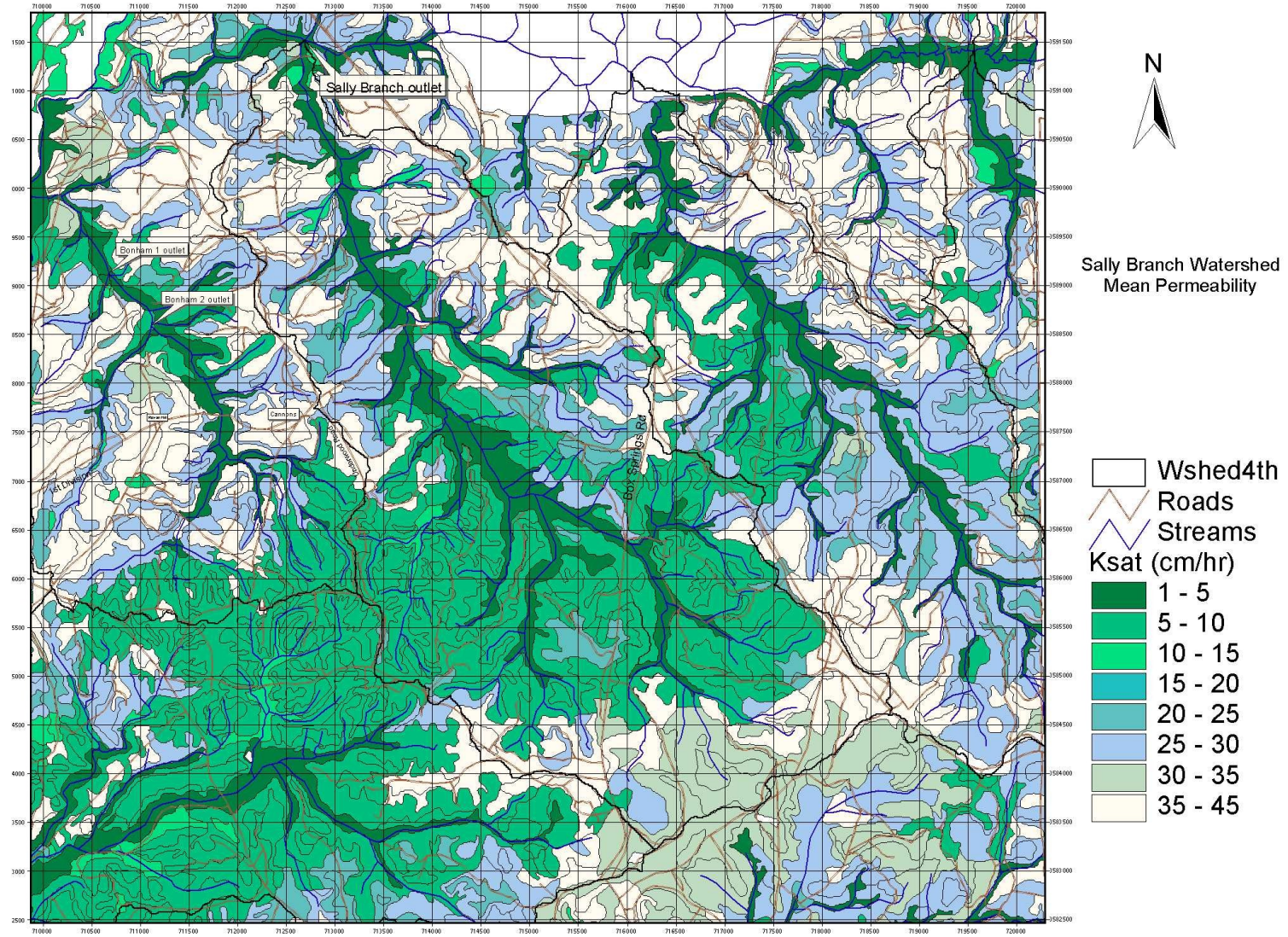
All sampled sites



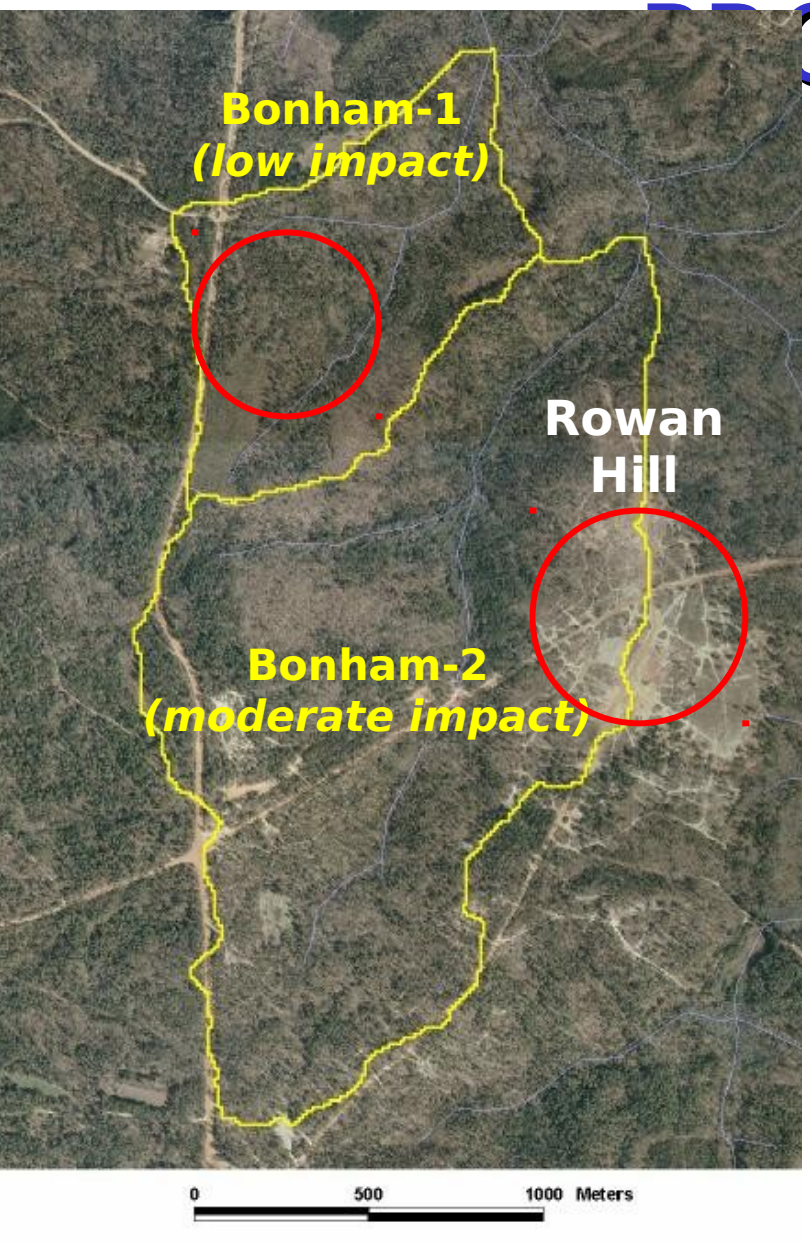
K_{sat} (cm hr^{-1})

SOIL HYDROLOGIC PROPERTIES

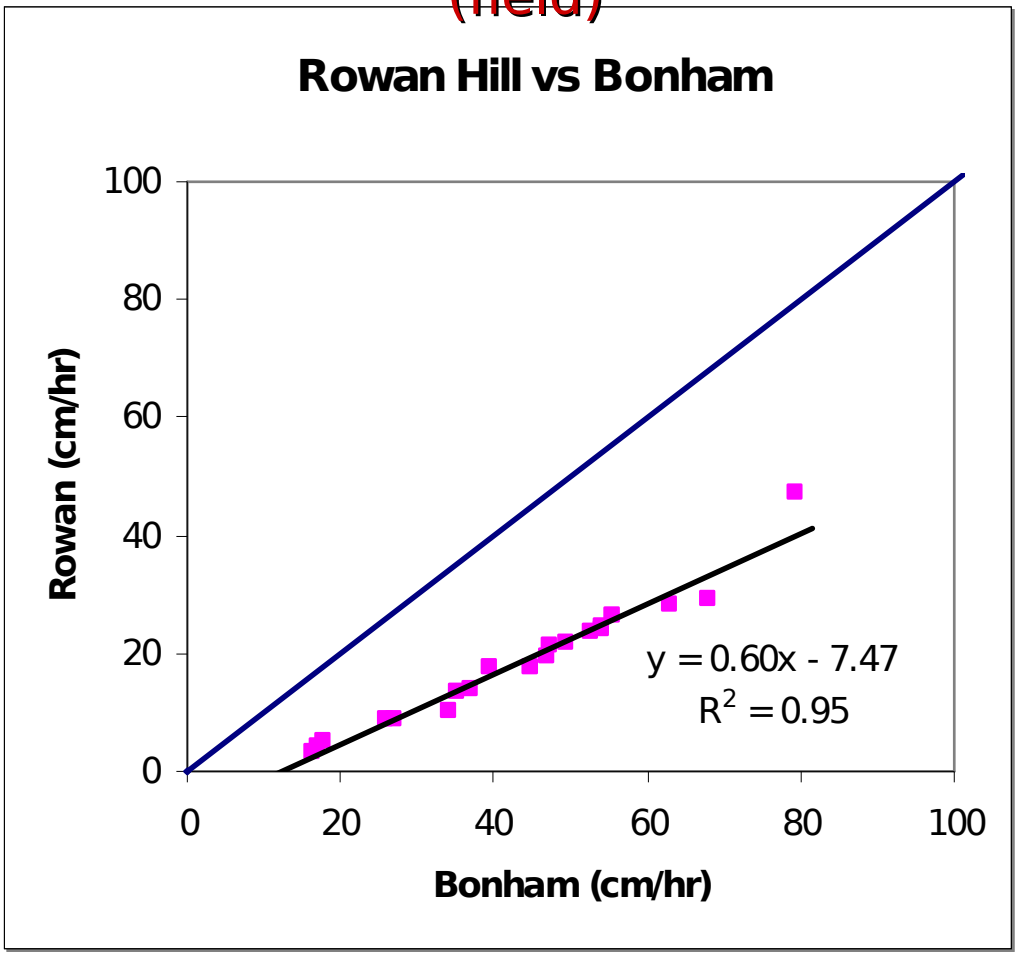
Permeability maps (baseline)

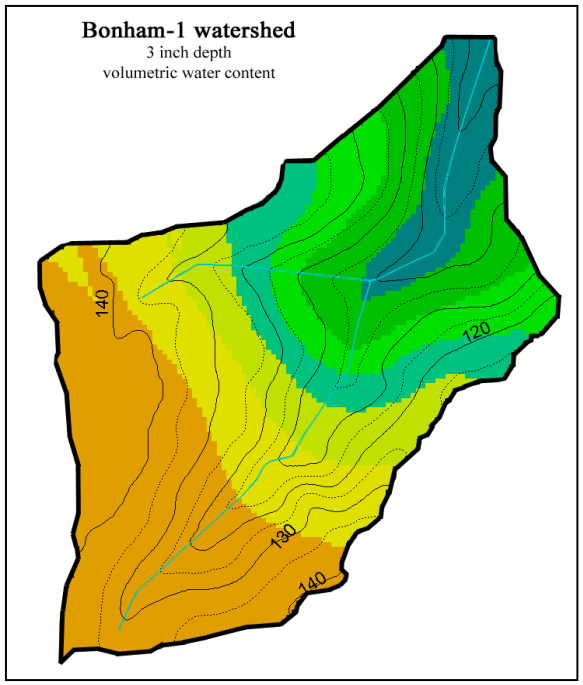


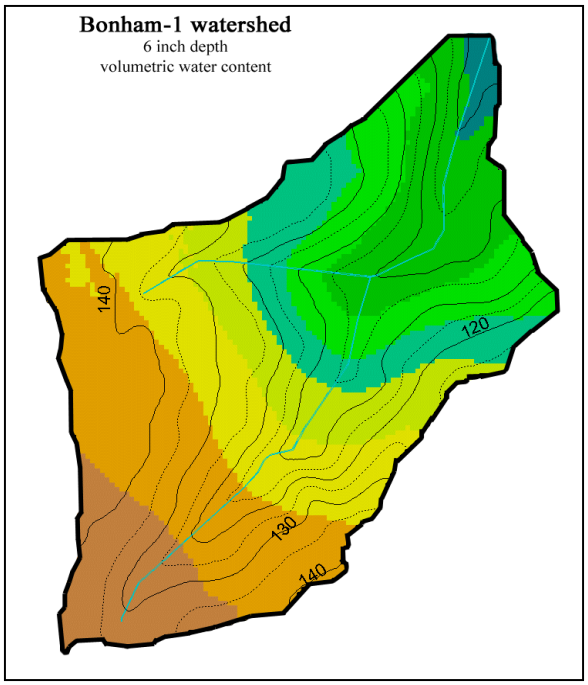
SOIL HYDROLOGIC PROPERTIES

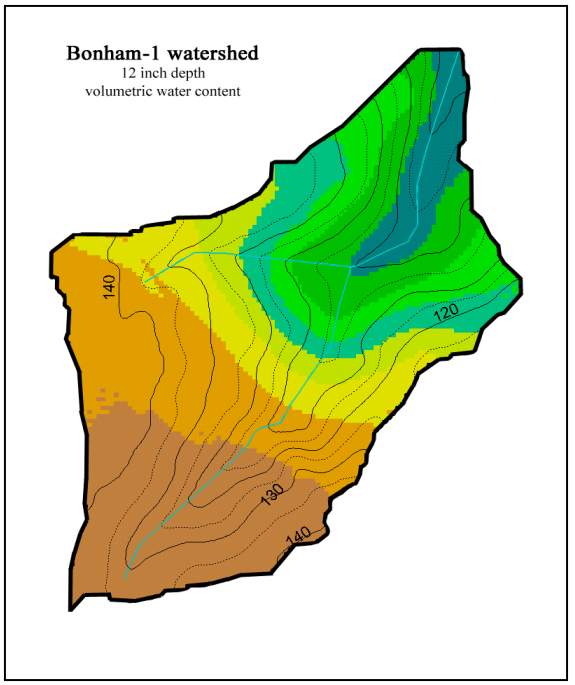


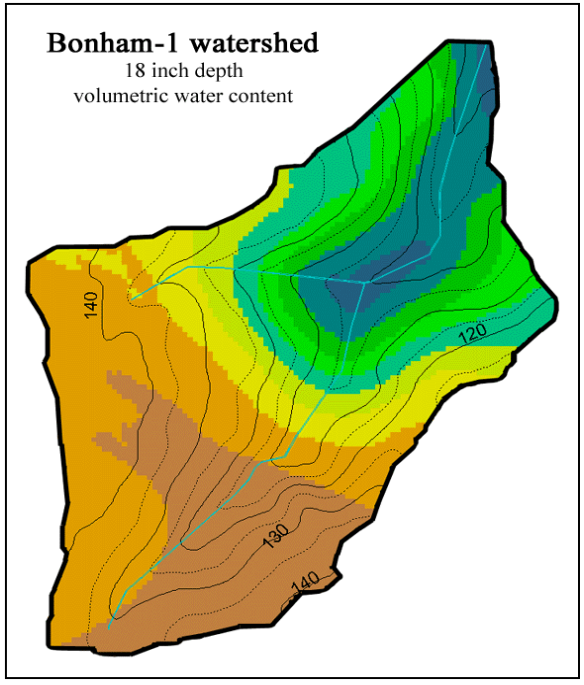
Saturated hydraulic conductivity (field)

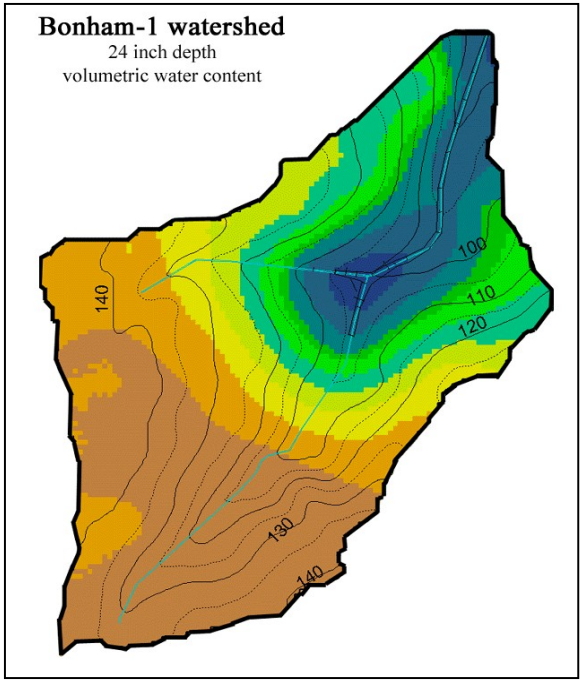


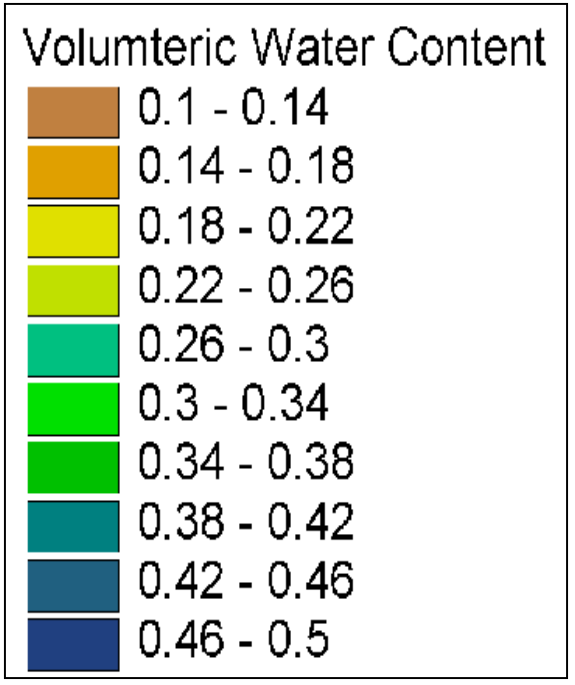

Bonham-1 watershed
3 inch depth
volumetric water content
140
120
130
140


Bonham-1 watershed
6 inch depth
volumetric water content
140
120
130
140

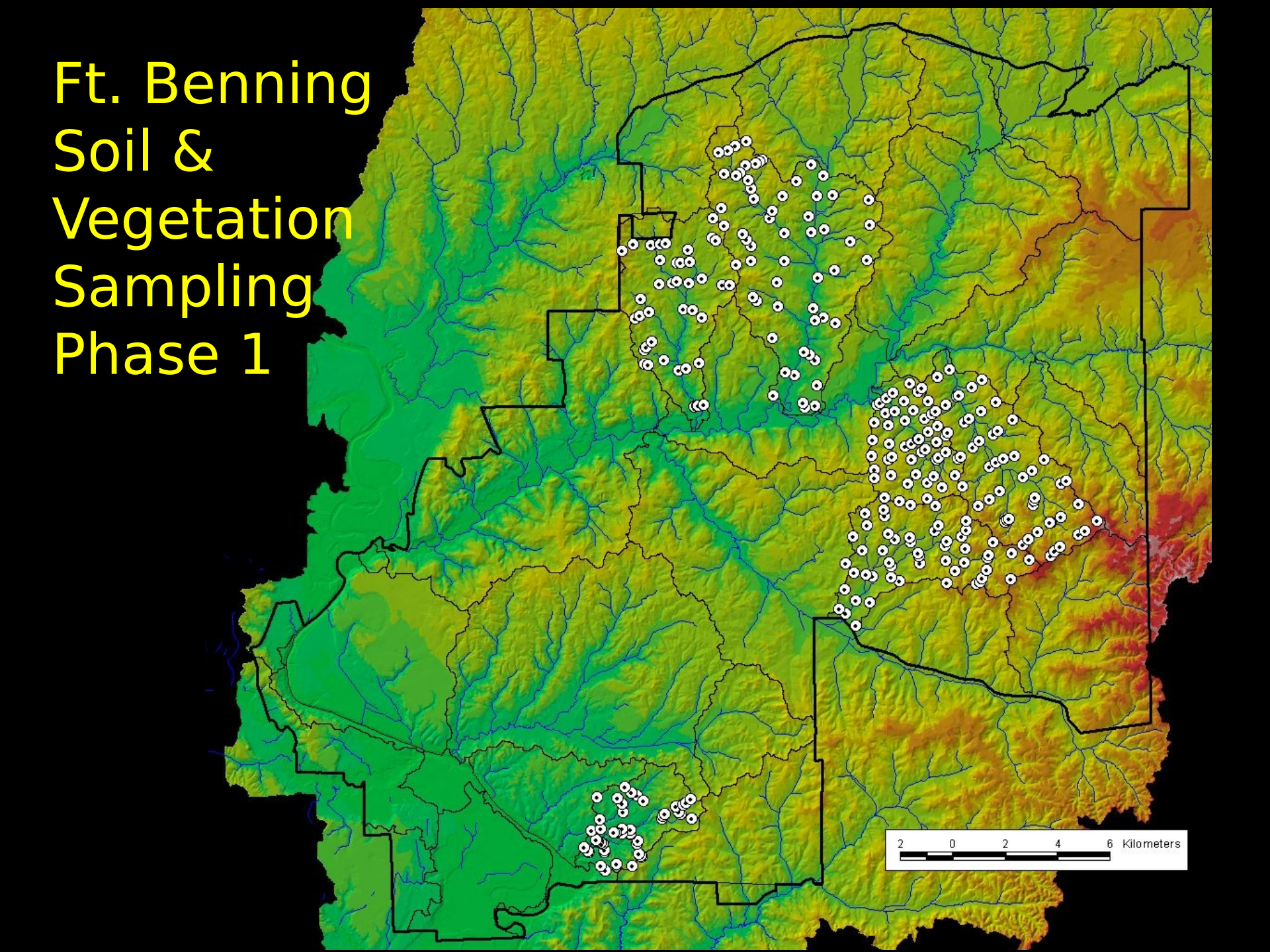

Bonham-1 watershed
12 inch depth
volumetric water content
140
120
130
140


Bonham-1 watershed
18 inch depth
volumetric water content
140
120
130
140


Bonham-1 watershed
24 inch depth
volumetric water content
140
100
110
120
130
140

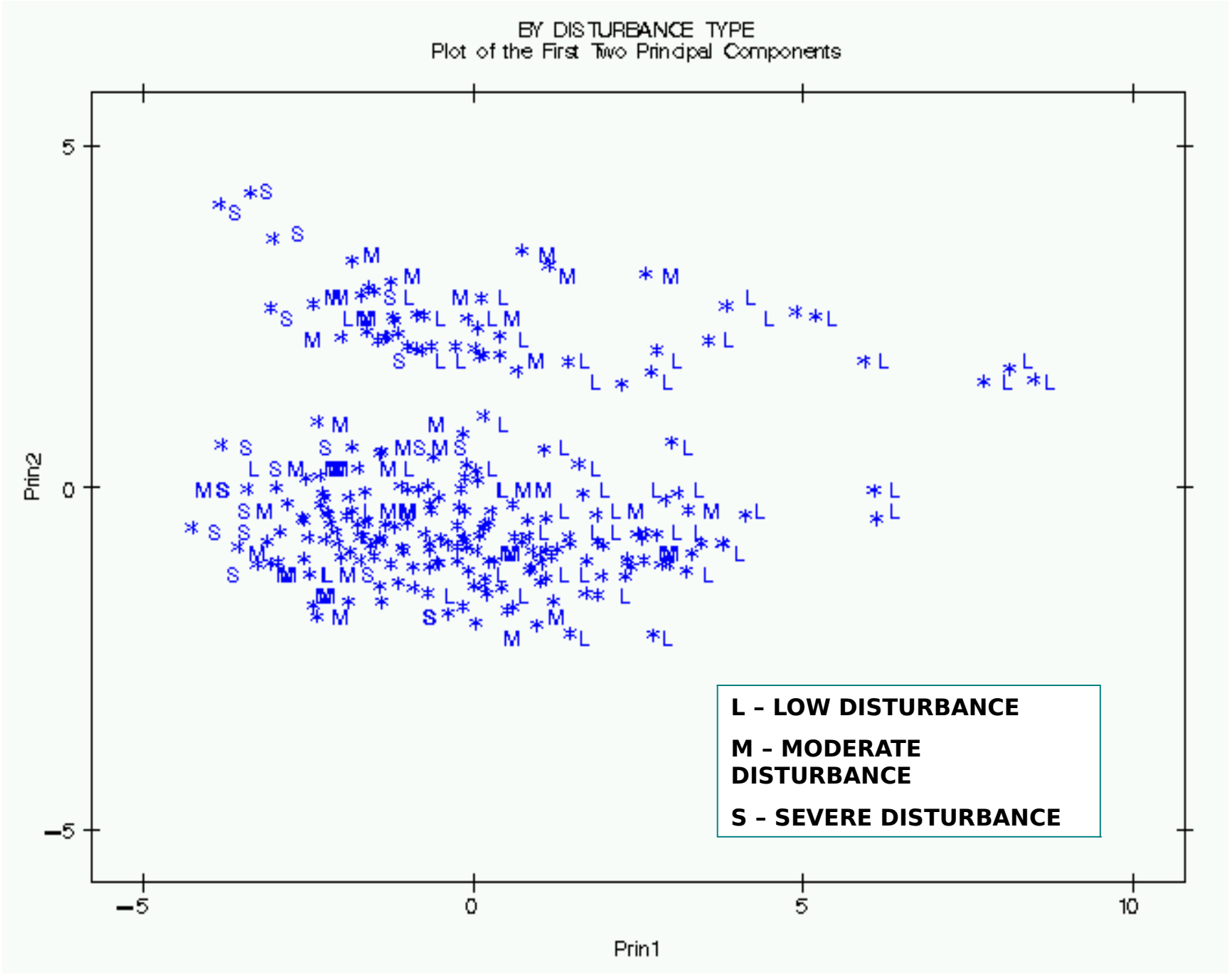

Volumteric Water Content
0.1 - 0.14
0.14 - 0.18
0.18 - 0.22
0.22 - 0.26
0.26 - 0.3
0.3 - 0.34
0.34 - 0.38
0.38 - 0.42
0.42 - 0.46
0.46 - 0.5

Ft. Benning Soil & Vegetation Sampling Phase 1

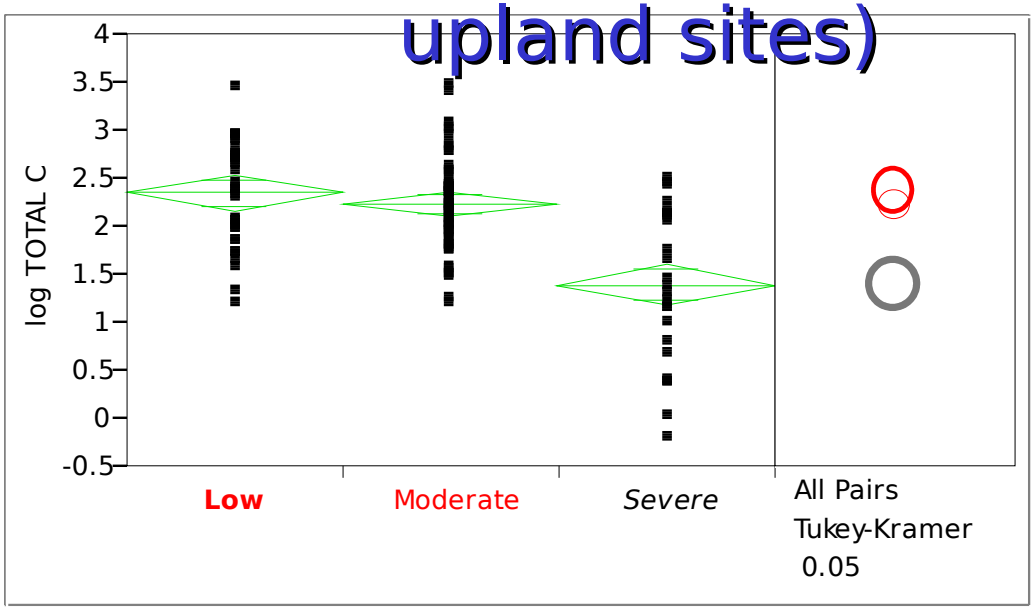


SOIL BIOGEOCHEMISTRY (PHASE 1) – PCA

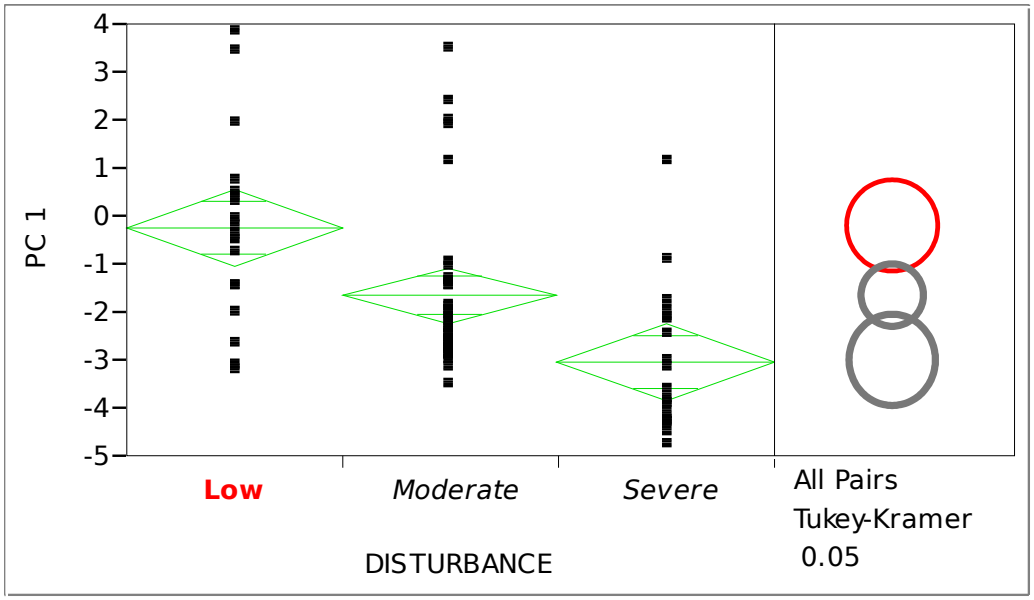
Variable	PC1	PC2	PC3	PC4
pH	-0.04464	0.19196	0.47556	-0.03252
Ash	-0.21636	0.05723	-0.09229	-0.14003
TP	0.32014	0.01422	0.08153	0.16704
Water ext. P	-0.00784	-0.33073	0.32933	0.22166
Oxal. ext. P	0.21212	-0.30061	0.18199	0.29731
Mehlich-P	-0.04075	0.06677	-0.17894	0.73750
Microbial P	0.10009	0.10062	-0.27765	0.26980
Total C	0.32534	-0.07971	-0.11885	-0.07608
Total N	0.34880	-0.03539	-0.03979	-0.02728
Wat. ext. C	0.07777	-0.29799	0.12880	-0.19046
Microbial C	0.23908	-0.03839	-0.32403	0.05156
Exch. NH4	0.18447	-0.25287	0.25378	0.18080
Microbial N	0.25785	0.17304	-0.03730	-0.18176
Mehlich Fe	0.26574	-0.13952	-0.08526	-0.24395
Mehlich Al	0.21172	-0.17601	-0.37136	-0.09566
Mehlich Ca	0.15578	0.44170	0.23081	0.07196
Mehlich Mg	0.21315	0.39823	0.16164	0.02645
Mehlich K	0.25224	0.35552	-0.00014	0.01396
Oxal. ext. Fe	0.28126	-0.14271	0.28251	-0.10606
Oxal. ext. Al	0.26992	0.05185	-0.02268	0.00485
Eigenvalue	7.1824	3.1807	2.1742	1.2988
% variance	35.912	15.904	10.871	6.494
% cumul. var.	35.912	51.816	62.687	69.181


BY DISTURBANCE TYPE
Plot of the First Two Principal Components
Prin2
Prin1
5
0
−5
−5
0
5
10
L – LOW DISTURBANCE
M – MODERATE DISTURBANCE
S – SEVERE DISTURBANCE

SOIL BIOGEOCHEMISTRY (Phase 1 upland sites)

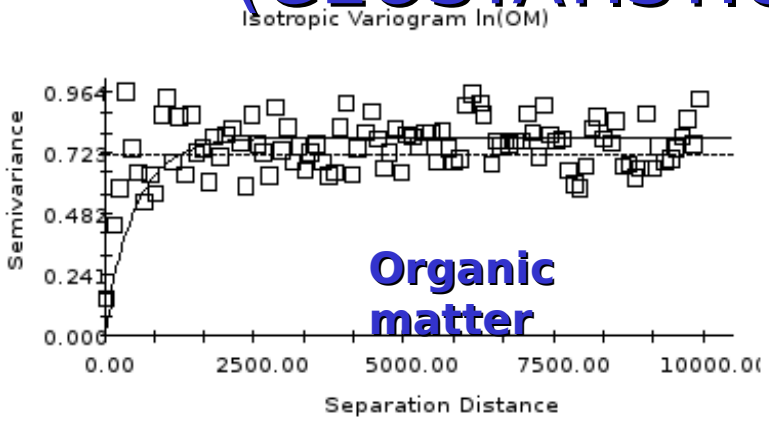


Total C (log)

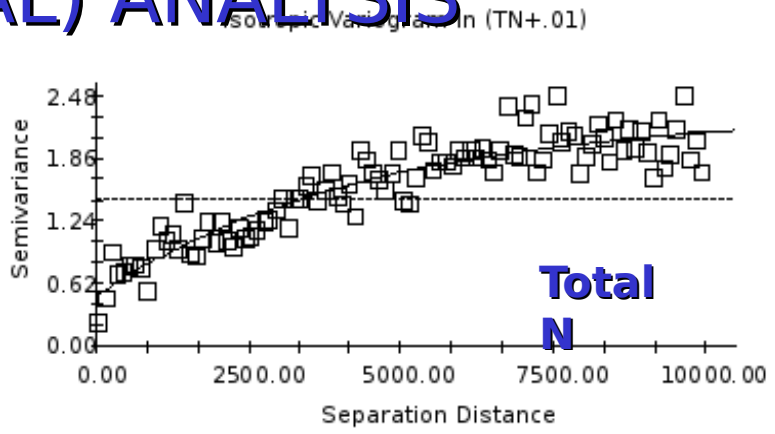


Prin. component 1

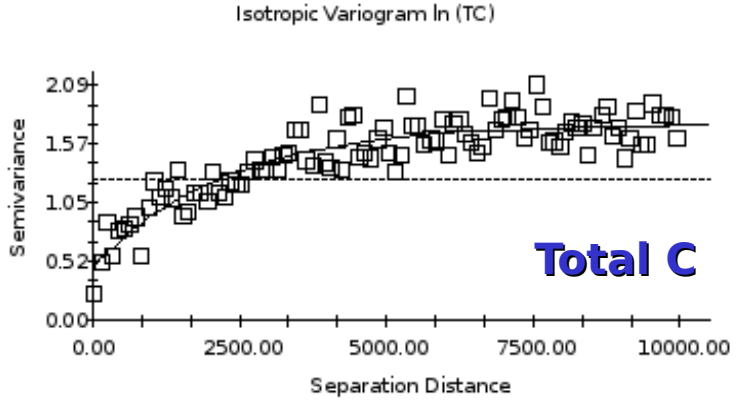
VARIOGRAMS FOR SPATIAL (GEOSTATISTICAL) ANALYSIS



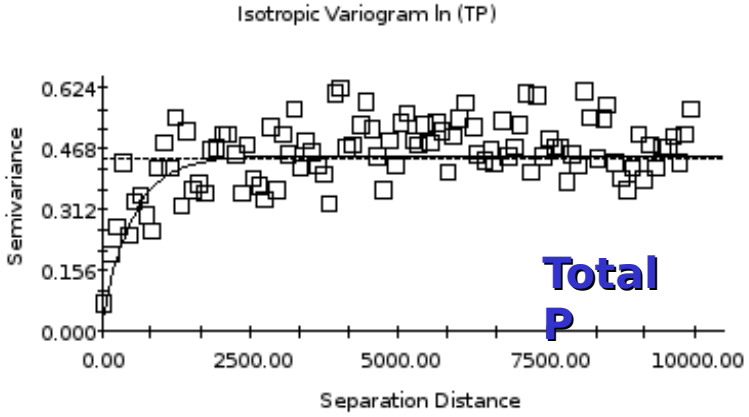
Exponential model (Co = 0.0000; Co + C = 0.7800; Ao = 500.00; r2 = RSS = 1.41)



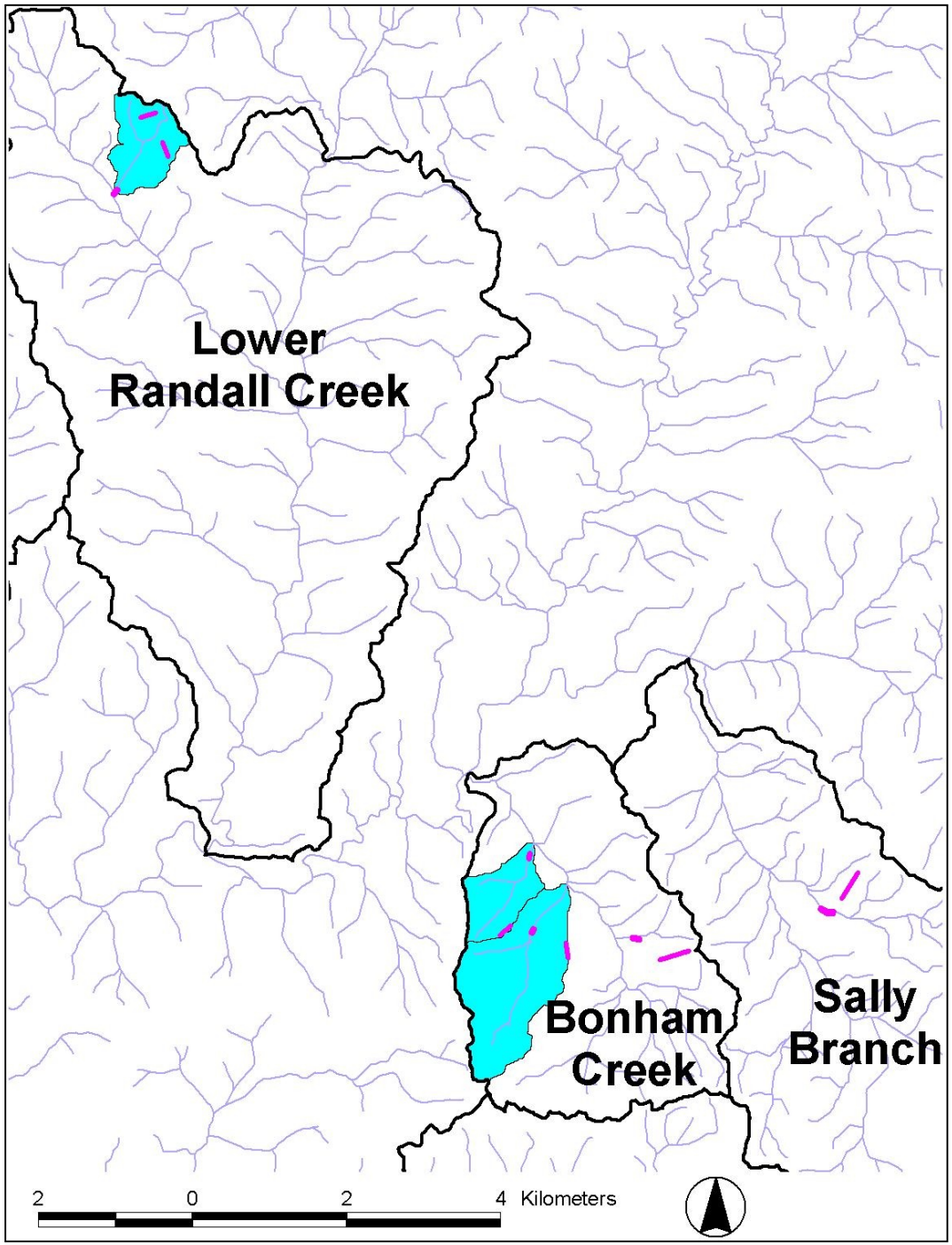
Exponential model (Co = 0.497; Co + C = 2.303; Ao = 4420.00; r2 = 0.
RSS = 3.71)



Exponential model (Co = 0.459; Co + C = 1.747; Ao = 2250.00; r2 = 0.809; RSS = 2.41)



Exponential model (Co = 0.0000; Co + C = 0.4500; Ao = 500.00; r2 = 0.419; RSS = 0.576)



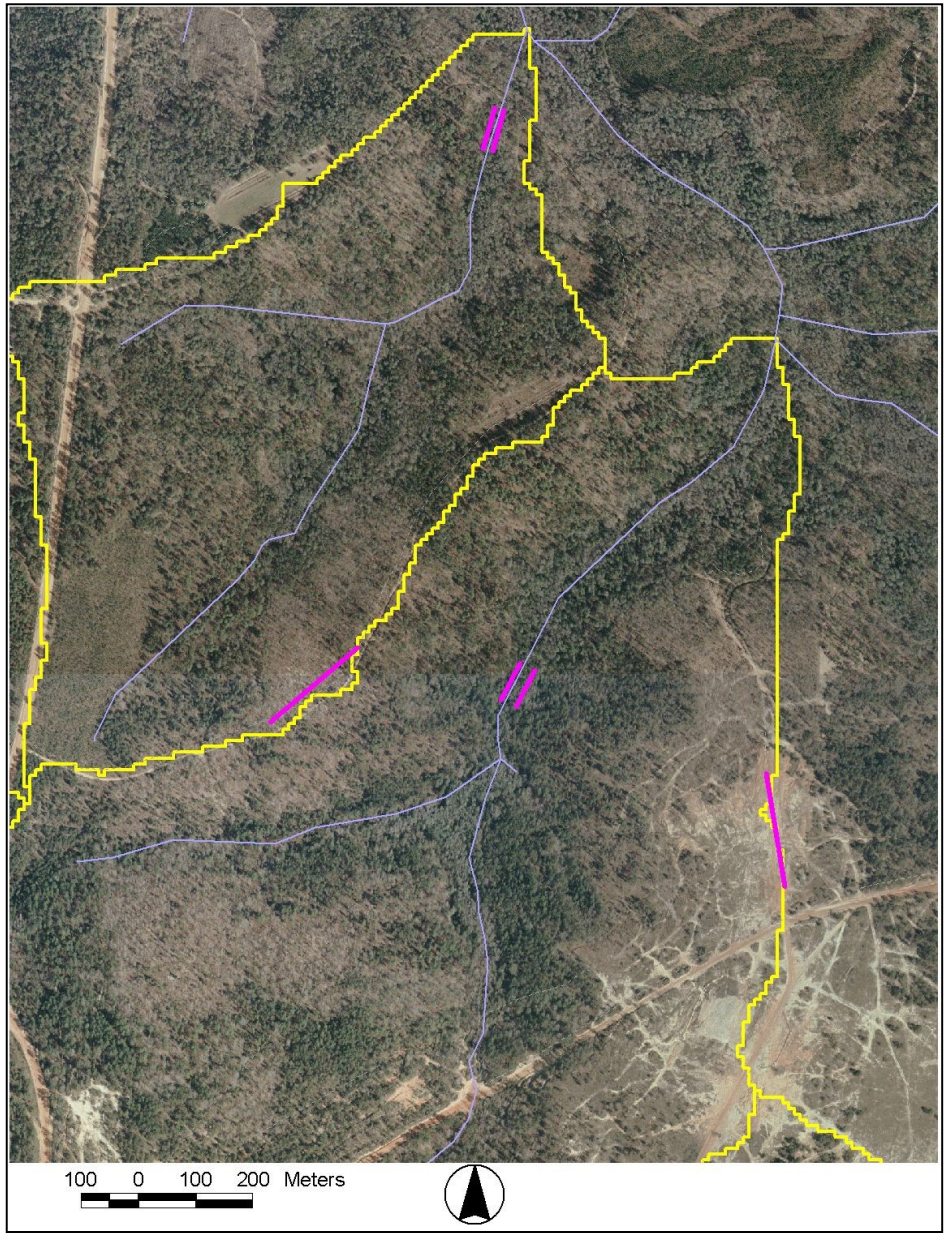
SOIL / VEGETATION TRANSECT SAMPLING (Phase 2)

- Upland area (200-400m length)
  - –Troup loamy sands
- Wetlands (80-100m length)
  - –Bibb soil series
- Sampled @ 20m (typical)

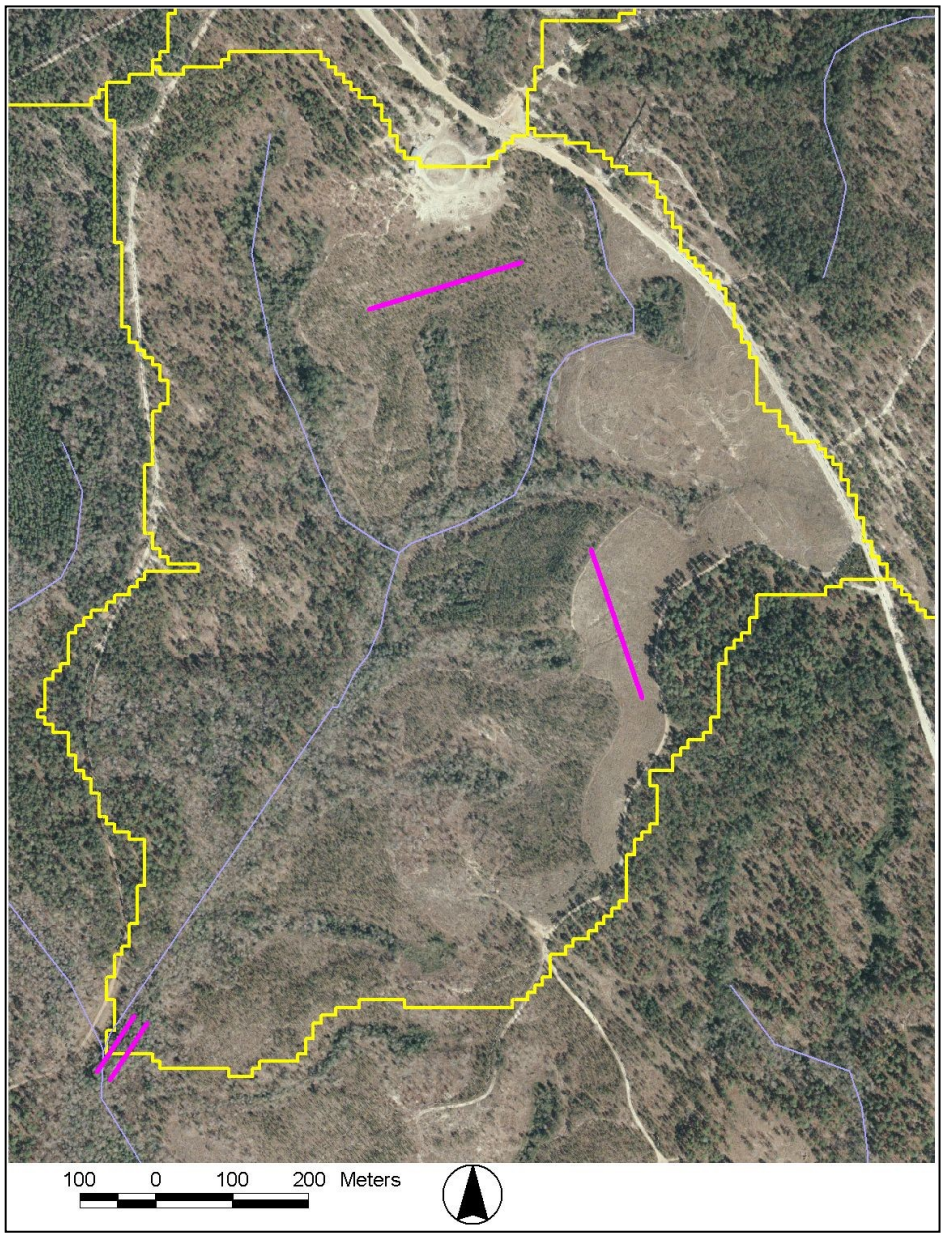
Characterize central tendencies and spatio-temporal variability:

- “homogeneous” sites
- gradients of military impact
- ecological gradients

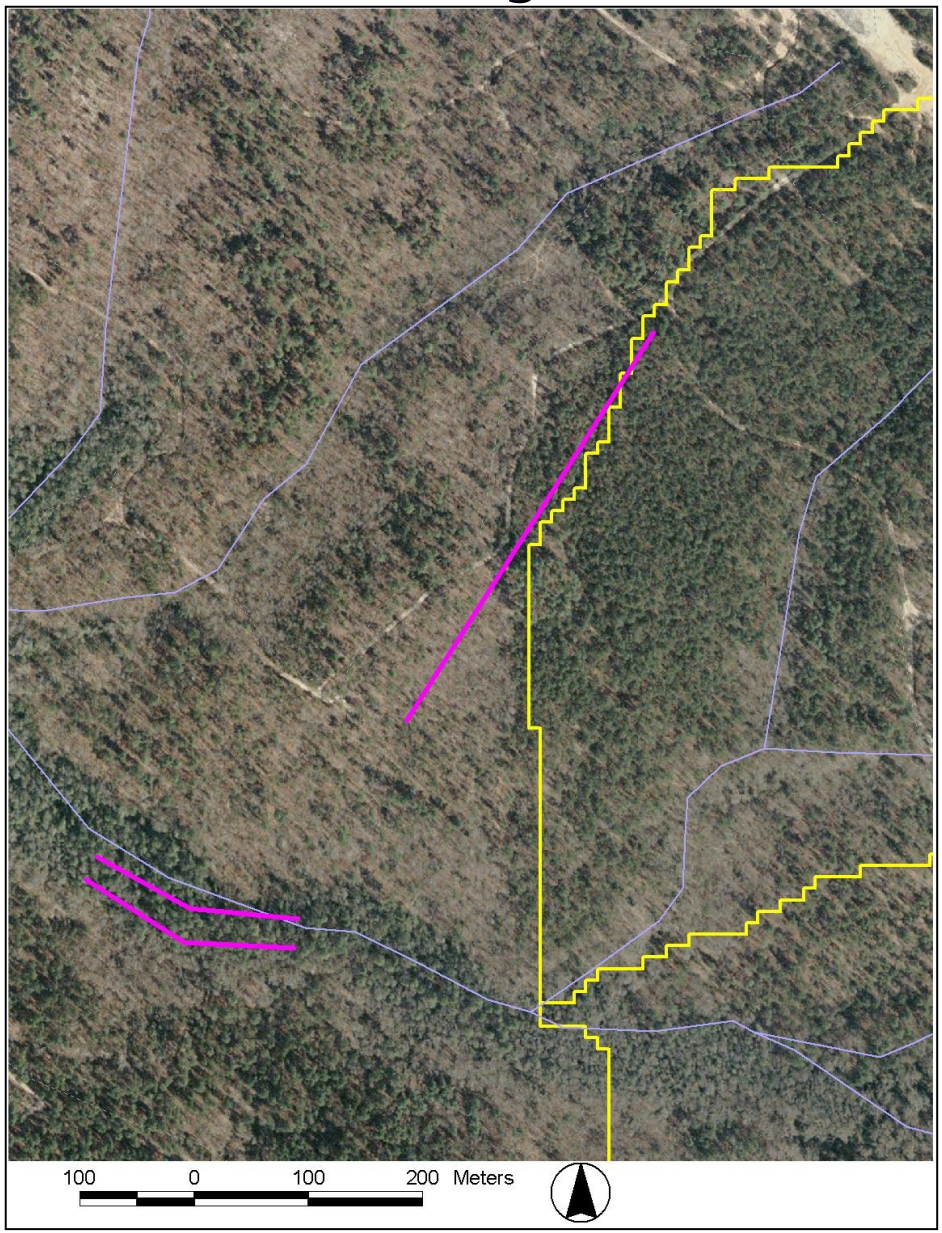
Military impacts



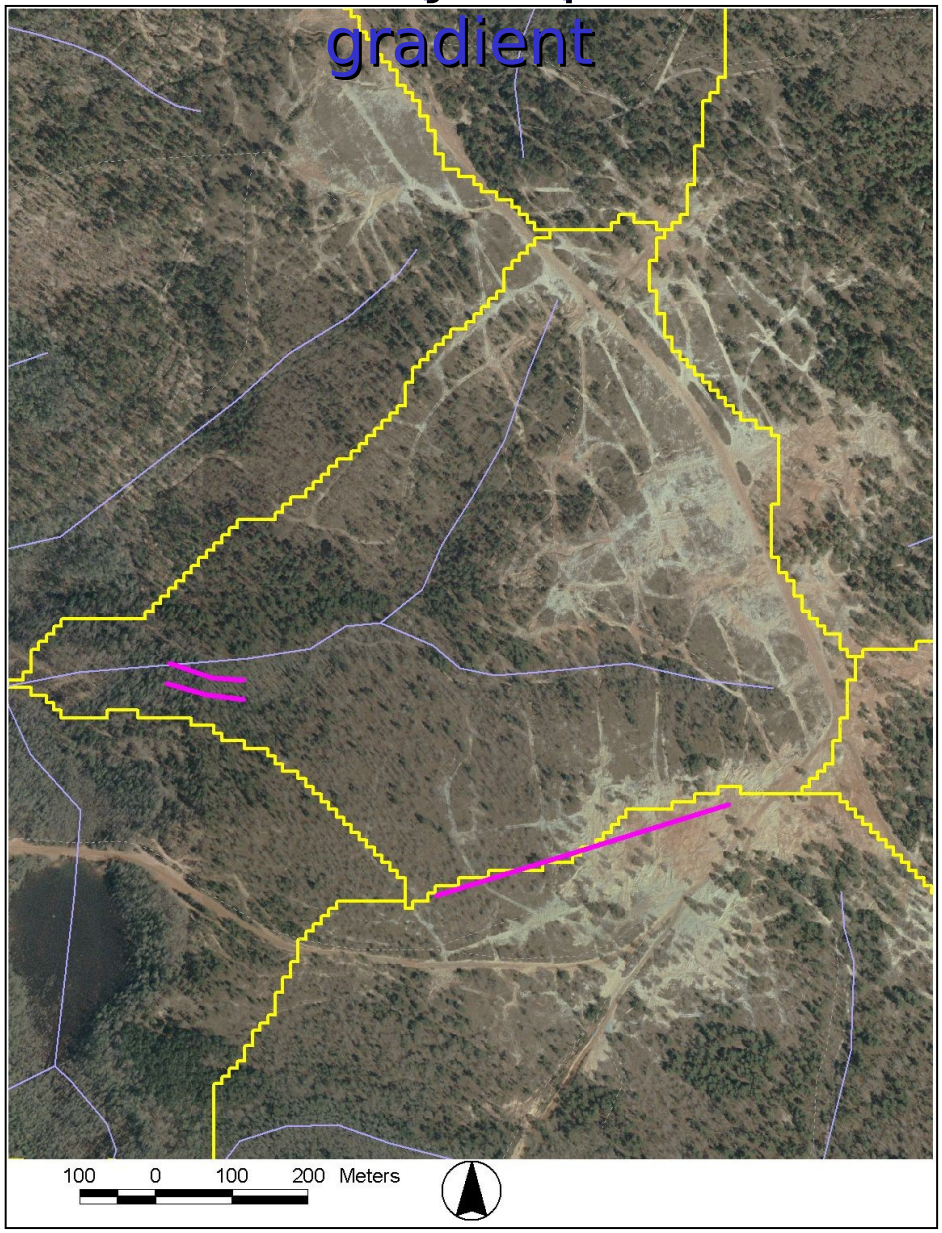
Forestry impacts



Land use gradient



Military impact gradient

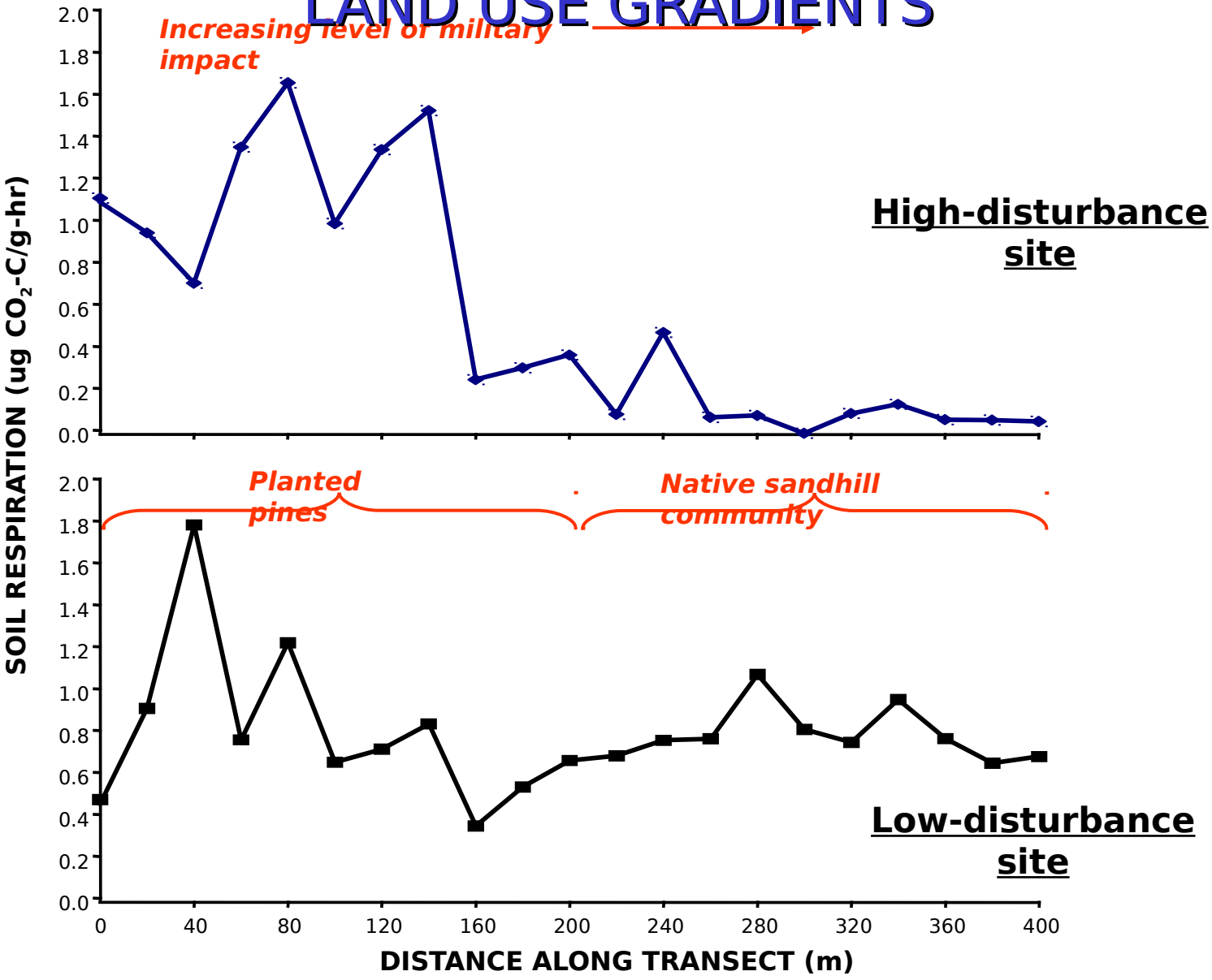


SOIL PROPERTIES ALONG DISTURBANCE AND LAND USE GRADIENTS

High-disturbance site – Military impact

Low-disturbance site – Land use/management

SOIL PROPERTIES ALONG DISTURBANCE AND LAND USE GRADIENTS



SOIL (MICROBIAL) ENZYMES

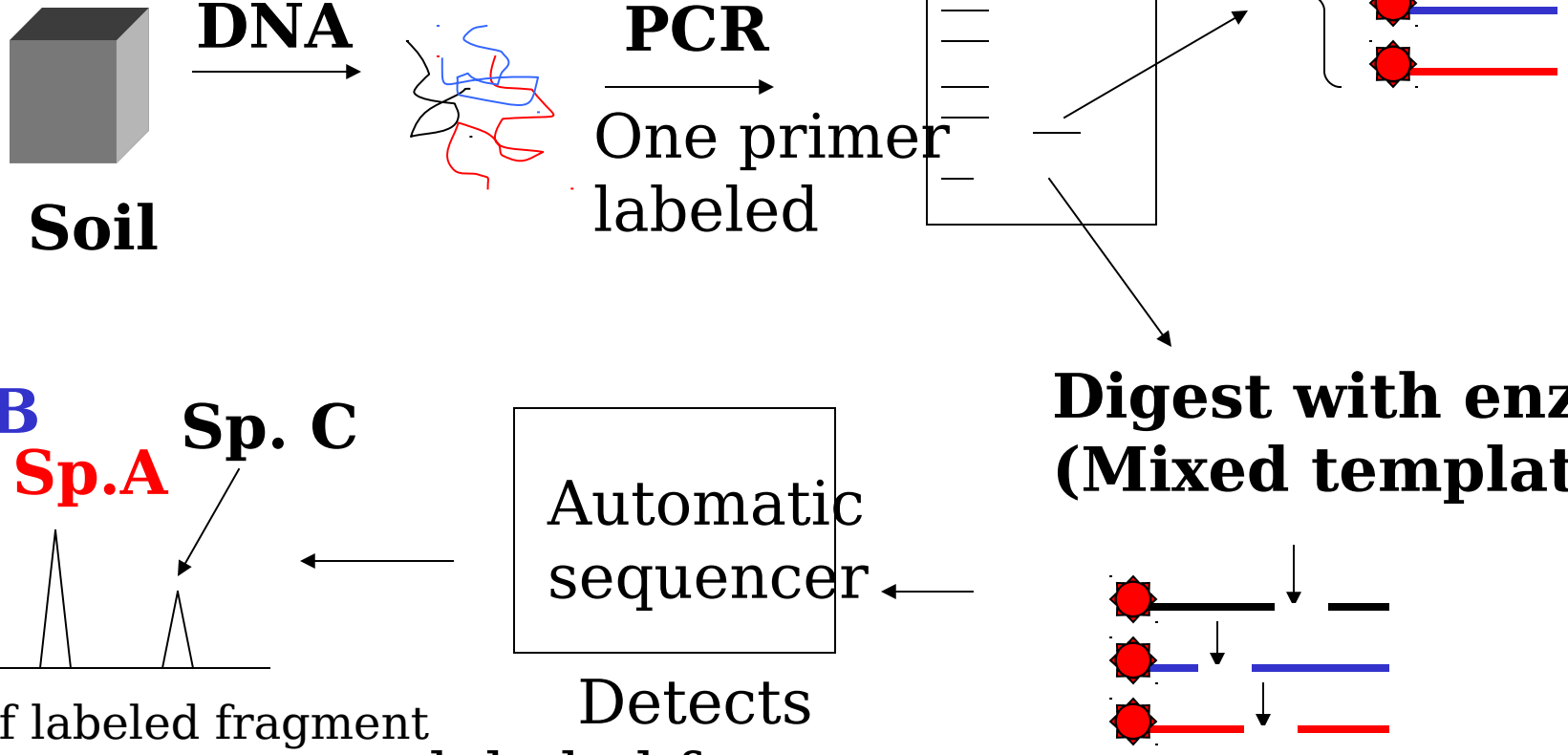
- Phase 1 (distributed) soil analysis
  - Acid phosphatase (AP), β- glucosidase (BG), dehydrogenase (DH), protease
  - Activity of AP, BG and DH generally inversely proportional to level (intensity) of disturbance
  - Phosphatase and dehydrogenase differentiated among certain types of disturbance
    - AP activities in sedimentation-impacted areas vs areas with visible burn marks (burned within 2 to 5 years) (P=0.05)
    - AP activities among low-impact, burned and tracked vehicle impacted areas ($P < 0.10$)
    - DH activities among areas with sedimentation, burn marks, tracked vehicle trails, and vegetation clearing ($P < 0.10$)

SOIL (MICROBIAL) ENZYMES

- Phase 2 (transects) soil analysis
  - Activity of AP, BG and DH generally inversely proportional to level (intensity) of disturbance
  - 87% of variance in AP activity explained by TP and water extractable carbon (WEC)
  - 92% of variance in AP activity explained by TP, TC, and potentially mineralizable nitrogen (PMN)

SOIL MICROBIAL ECOLOGY

T-RFLP Analysis

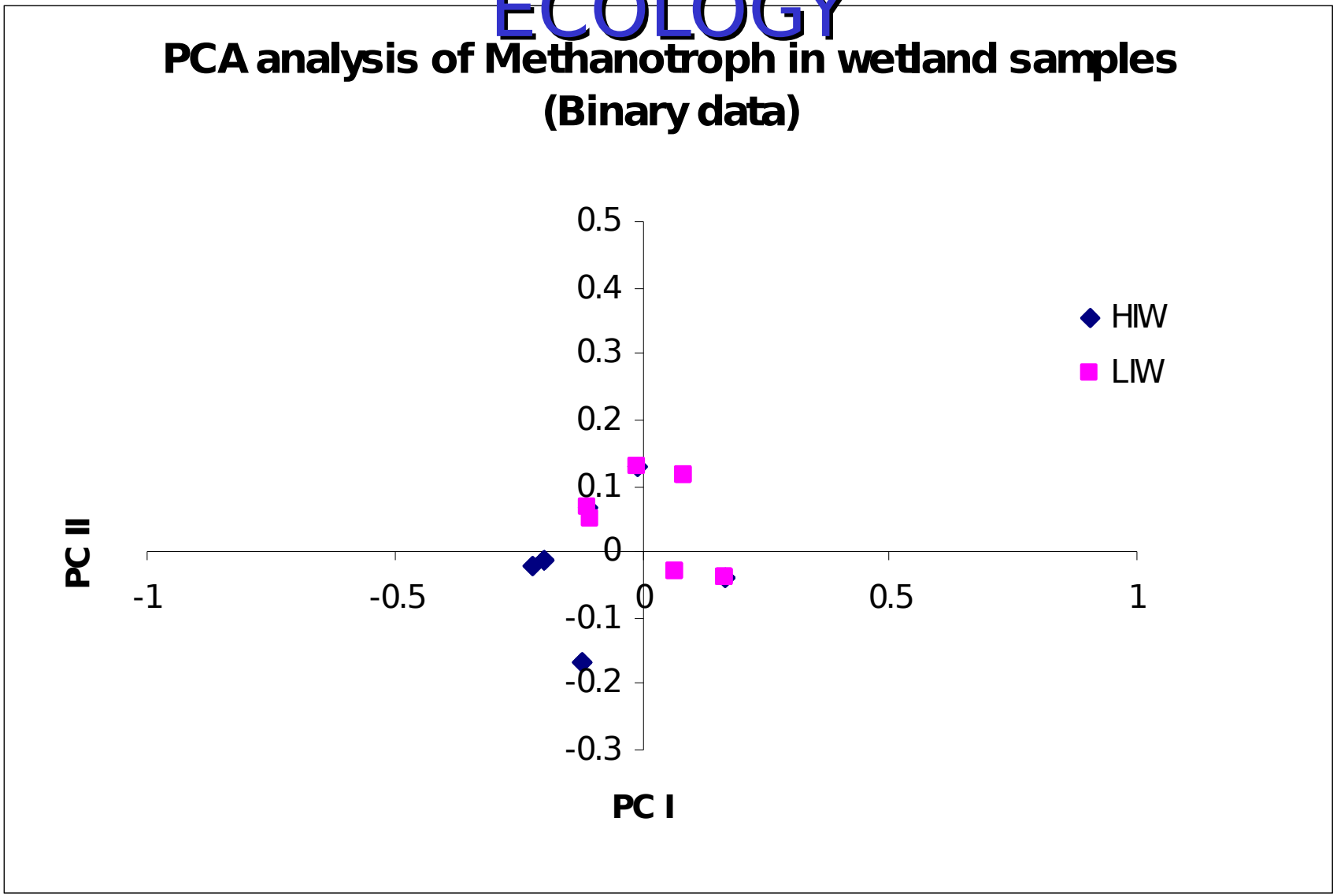


SOIL MICROBIAL ECOLOGY

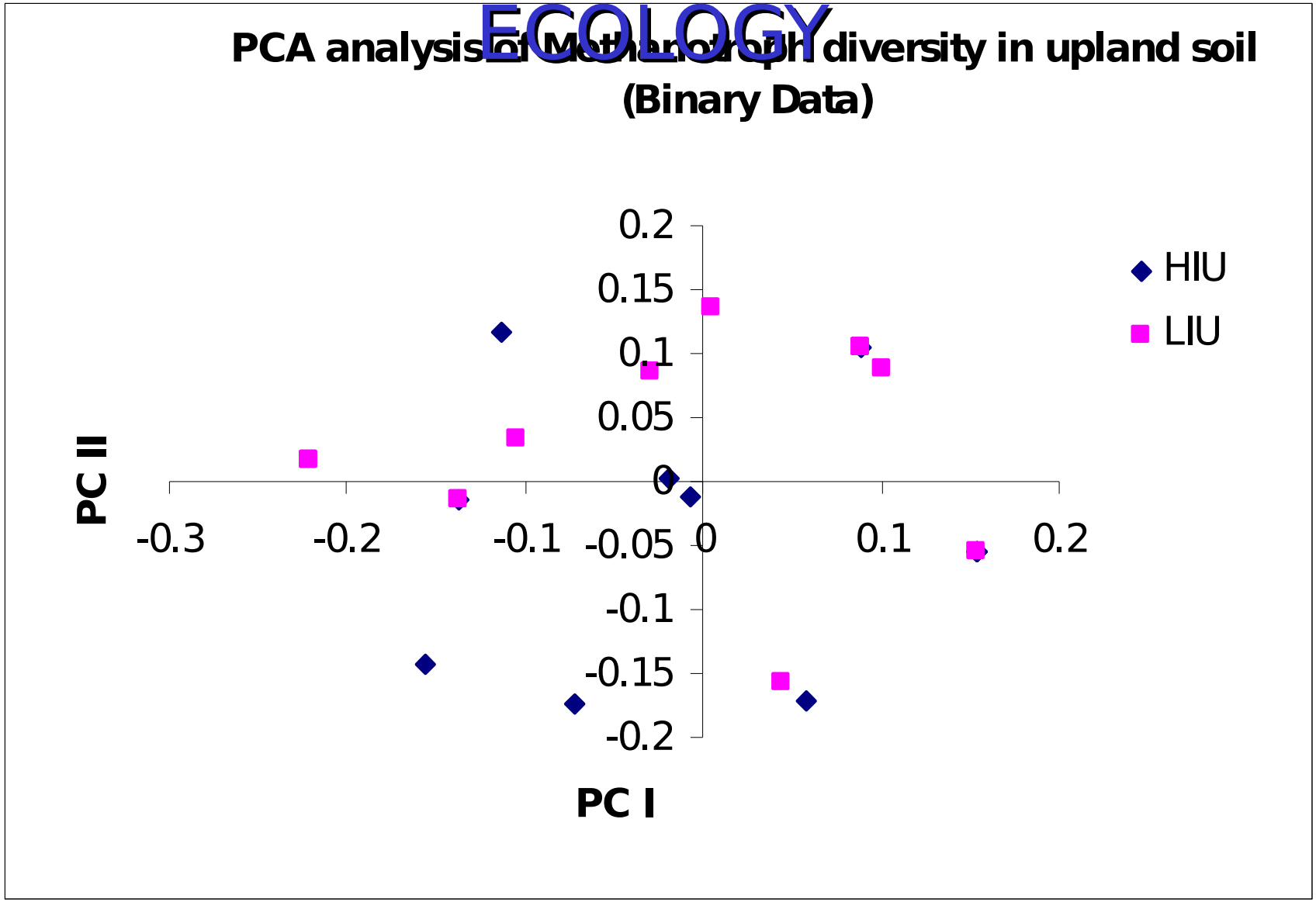
Methanotrophs

- Oxidize methane as carbon energy source.
- Two groups:
  - Type I: dominate under low methane, high O_2 conditions. No methanotrophs detected in our samples
  - Type II: dominate under high methane, low O_2 conditions. Present in most samples.

SOIL MICROBIAL ECOLOGY



SOIL MICROBIAL ECOLOGY



VEGETATION

Phase 1 monitoring:

- Vegetation sampled late summer-fall (maximum standing biomass and flowering)
- Cover
  - Ground cover herbaceous:
    - Foliar cover by species, bare ground and litter estimated in three 1m2 quadrats at each site
  - Shrub/midstory woody plants (< 2 m tall):
    - Cover of shrub/midstory measured along three 5 m line intercepts radiating outward in three random directions from the sampling point
  - Overstory canopy cover estimated with a densiometer

VEGETATION

Phase 1 monitoring (cont.):

- Above-ground standing crop biomass and nutrient concentration of shrubs and herbs clipped in 1 m^2 quadrats; litter collected – 1 m^2 quadrats
- Biomass samples ground and tested for N and P concentrations
- Density of pine seedlings, broomsedge bluestem and low panicums estimated in three 1 m^2 quadrats/ site

VEGETATION

Phase 1 monitoring (cont.):

- Multivariate methods – relate to soils and land use
  - Ordination (DECORANA)
  - Cluster analysis (TWINSPAN)
  - Exploratory techniques using a combination of ordination and regression (CANOCO)

VEGETATION

Phase 2 studies:

- Forest management study (harvesting chronosequence)
  - Long-term responses of ground cover species composition and diversity to soil disturbance associated with forestry practices
  - Site selection completed summer 2001
  - Vegetation and soil sampling completed fall 2001
- Response to military disturbance
  - Collocated with soil biogeochemistry and soil hydrologic sampling
  - Transects across disturbance, land use and ecological gradients

OBSERVATIONS…

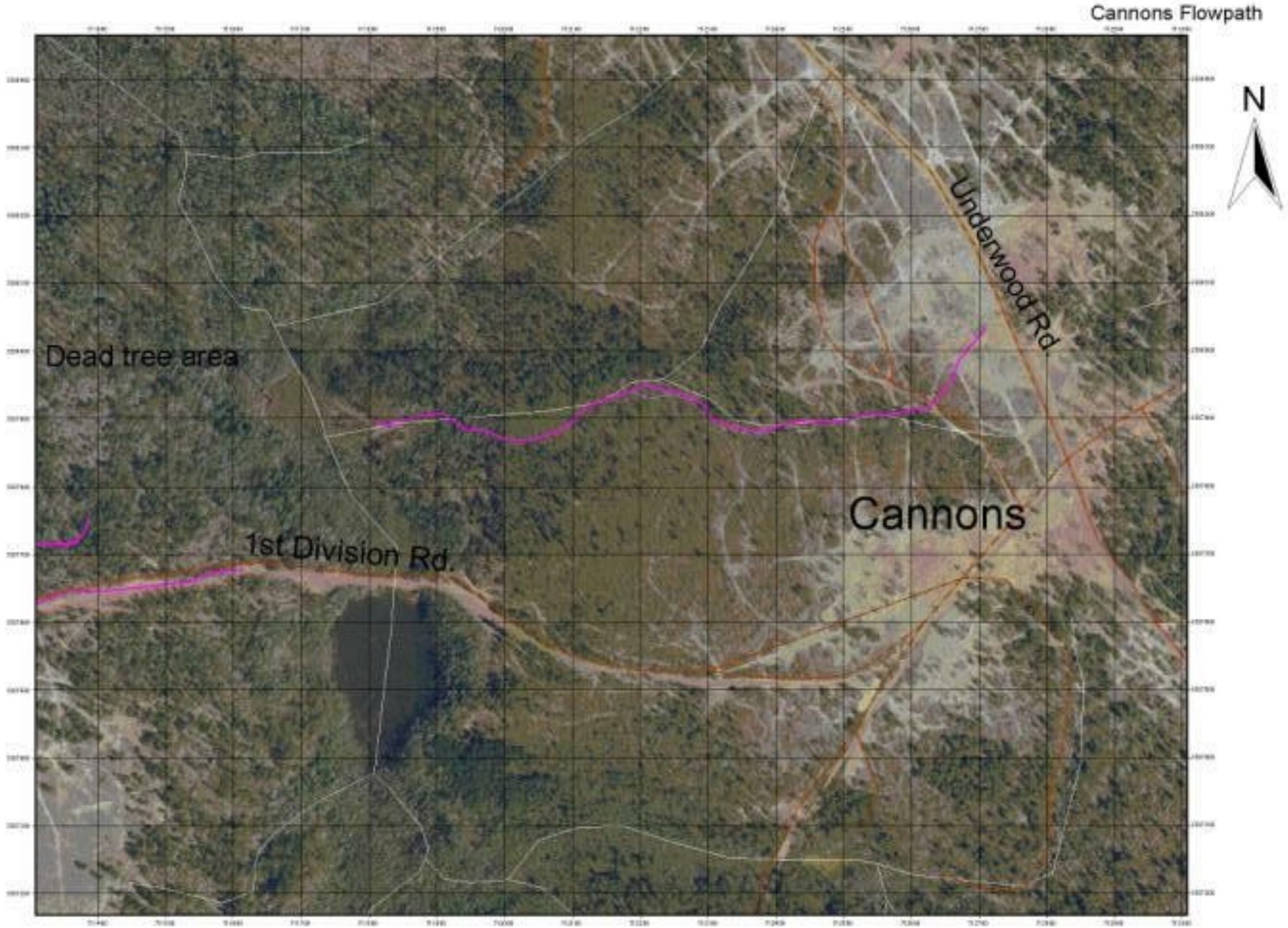
- Ecological manifestation of military disturbance (w.r.t. soil, understory vegetation and hydrology)
  - Loss of A (organic) horizon in uplands → soil OM, nutrients, water storage
  - Loss of E (sandy) horizon under severe / chronic disturbance → infiltration capacity (hydraulic conductivity), water storage
    - Potential long-term ecological impacts
  - Sedimentation in wetlands → clay, silt, sand (extreme cases)
    - Changes in soil properties → OM content, nutrient partitioning
    - Significant ecological impacts from heavy

3. 1. 2000

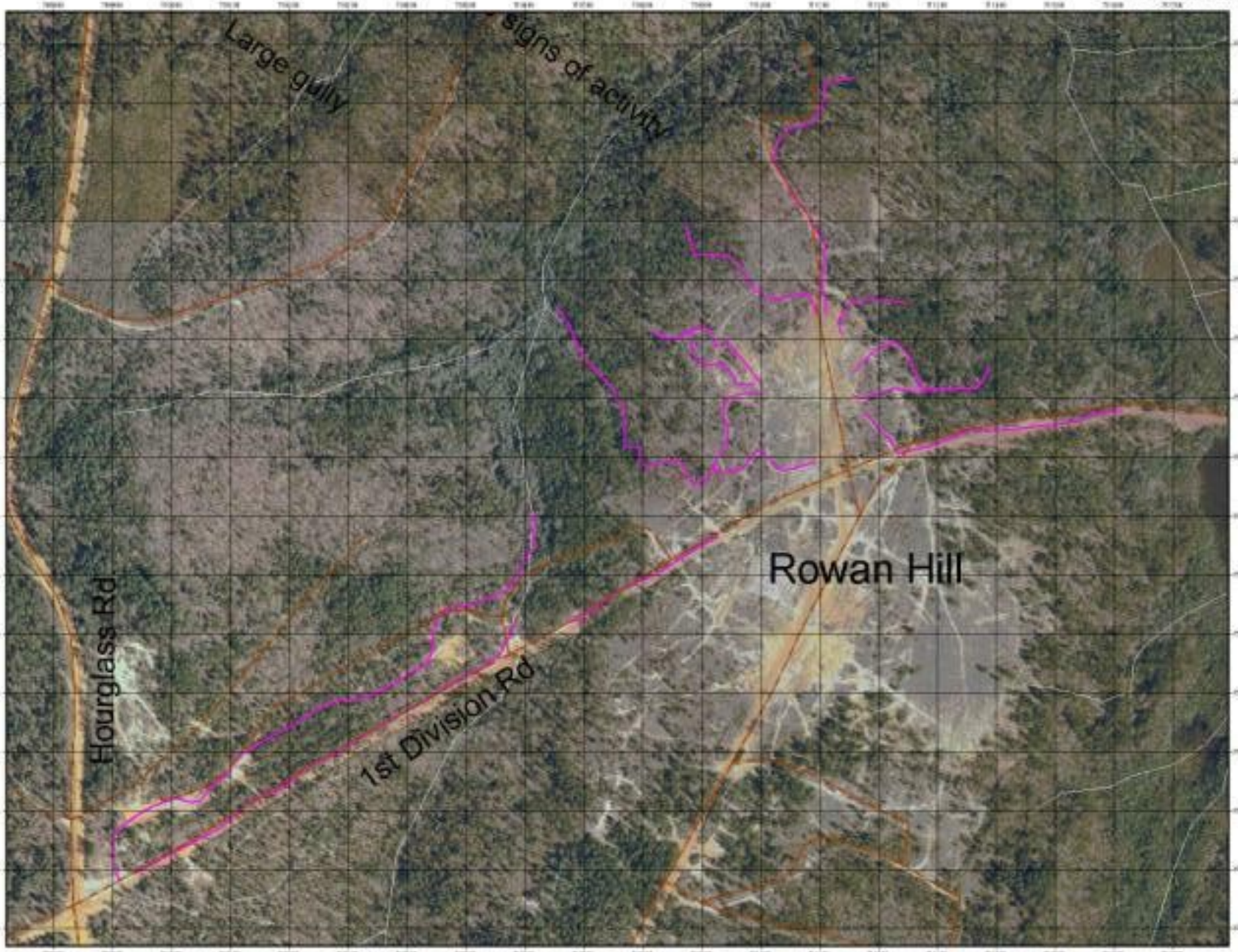
OBSERVATIONS…

- Importance of unpaved roads in surface runoff / sediment transport
  - Military vs. logging roads (frequency of use, maintenance)
  - Road grade / direction (down-slope or across-slope)
  - Stream crossings

Bonham 1 Flowpaths
Test Plot
Hourglass Rd.
Planted Pine
N


Cannons Flowpath
N
Underwood Rd.
Dead tree area
Cannons
1st Division Rd.

Rowan Hill Flowpaths



OBSERVATIONS…

- Site impact assessment
  - ECMI characterization for > 300 sites
  - Bare ground / ground cover assessment completed for > 60 sites (Phase 1 soil / vegetation 3X sites)
  - Scale dependency issues, e.g. plot size, transects, watersheds

ANTICIPATED PRODUCTS